Univ. of
Toronto
Library

Biological
& Medical
Serials

P
Hall
Biol
P

POMONA COLLEGE JOURNAL
OF ECONOMIC BOTANY
AND SUBTROPICAL HORTICULTURE

Biological
& Medical
Serials

Volumes One, Two and Three

1911-1912-1913

143049
19/6/17

PUBLISHED QUARTERLY

BY THE

DEPARTMENT OF BOTANY, POMONA COLLEGE

CHARLES F. BAKER, Editor

CHARLES FULLER BAKER, M. A.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume I FEBRUARY 1911 Number 1

Foreword

THIS JOURNAL has been established first and foremost in the interests of the scientific development of the new Subtropical Horticulture, and of a more scientific knowledge of the many plants which have made and will make Southern California one of the richest garden spots on Earth, and which promise great possibilities also for other similar regions.

In the recent rapid growth of the vast subtropical regions lying between the distinctively temperate areas and the well defined tropics, a flood of new plants has been pouring in from farther north as well as from all of the Tropics of the World. Trees, shrubs, and herbs from the North are comparatively well known, but exact knowledge concerning the myriads of valuable things constantly being imported from farther south and from other foreign lands is always a great desideratum. There is very acute and special need in this connection for all of that more exact knowledge which comes under the general head of Economic Botany. The call for this work is constant and urgent from growers, planters, amateur fanciers, greenhouse-men, nursery-men, seed-men, importers, experimenters and botanists.

Coming with these new plants are many little known fungous and bacterial diseases which, under the new conditions, frequently accomplish most dire and alarming results. In these and other matters, Subtropical Horticulture possesses a multitude of serious problems, both old and new, which are all its own.

This JOURNAL will be dedicated to the publishing of the best obtainable new and original results along all of these lines, and our contributors will include some of the most practical, capable, and energetic students and investigators in the country, and we shall also select for it some of the best results that we are able to produce here at Pomona College. We shall, so far as possible, avoid the extremely technical, and employ every effort to make the JOURNAL thoroughly readable and clearly and abundantly illustrated. Though always it should be remembered as true, just as in other lines of modern human effort, *that the safest, best, and most successful practice, is ever that which is based upon detailed and fundamental technical knowledge.*

None of those interested in this enterprise have the slightest expectation of the JOURNAL ever becoming a paying proposition, though they hope ultimately to make it self supporting. Its primary function is that of an effective educational tool, and an active influence in building up safer, more extensive, and more remunerative scientific horticulture for subtropical regions, and a more complete and thorough Economic Botany for all of the plants in question.

The subscription price has been placed at a merely nominal figure, in order that the JOURNAL may be within the ready reach of all. We shall make definite plans always to offer returns in far greater values, not only to residents throughout the subtropics, but also to warm-house interests, plant fanciers, horticulturists, and economic botanists the world over. Each year's volume of four numbers will be complete by itself, and each year undertaken will in any event be completed, but any given year will be undertaken only when sufficient funds are in sight to cover its bare running expenses. Many notable friends of this work tell us that *without doubt* steady support for so important an undertaking will be forthcoming.

A. J. COOK
C. F. BAKER

The Avocado in Southern California

BY F. W. POPENOE*
PASADENA, CALIFORNIA

That the avocado will succeed in Southern California has been proved conclusively by the seedlings planted fifteen to twenty-five years ago which are now bearing, and by more recent experiments with budded trees; and the establishment of an avocado industry in the immediate future is assured. As to whether we shall proceed at once to the production of the best fruits or whether the loss of much money and time with the incident disappointment to all concerned shall be caused by the planting of inferior varieties is the vital question at this moment. It is to the solution of this problem that the earnest endeavor and careful efforts of all our nurserymen should be directed, and it is in the hope that some help may be given in eliminating wasteful efforts that this article is written.

For centuries the avocado has been grown in Mexico and other tropical countries, propagated only by seed. Like other fruit trees grown from seed, it comes true in but a very small percentage of cases. This has led to the existence of a wide range of varieties. All avocados so far fruited in California are these mere chance seedlings, most of them of indifferent value and not worth propagation on an extensive scale. There are many varieties of good size and flavor, fruiting in Mexico and other parts of the tropics, which will doubtless succeed here as well as the smaller and inferior ones. Some of these Mexican varieties are of such superior quality as to leave nothing to be desired.

It is therefore manifestly the part of wisdom for California planters of this fruit to proceed with intelligence and accept nothing but the best. Attracted by prospective large returns some investments of a doubtful character are already being made. There is really no excuse for this.

Investigation and care will lead anyone in the right path. There will be no demand for seedling or inferior fruits once a superior avocado is to be found plentifully in our markets. Nor need there be delay or groping in the dark for these superior varieties. At our very door lies a boundless experimental garden in which for centuries the avocado has been grown, where countless varieties have originated, and where now are growing hundreds of thousands of trees from among which we have only to select the best.

By taking advantage of this opportunity California can obtain in a comparatively short time the choicest varieties, which it would take years of time and a large expenditure of money to produce by the ordinary methods of plant breeding, carried on here.

The results presented in this preliminary paper on this subject have been worked up in the Biological Laboratory of Pomona College, and acknowledgments are here made for the facilities placed at my disposal there and the constant and kindly assistance extended to me.

*Special student in Pomona College.

TYPES GROWN IN CALIFORNIA

Broadly speaking, the avocados which have fruited here so far may be divided into two classes; those of Mexican origin, which include all the smooth and thin skinned varieties, and those of Guatemalan origin, which are easily distinguished by their very thick skins and rough exterior. This is not saying, of course, that all avocados can be divided into these two classes.

Figure 1. At left the parent tree of the Blake Avocado, growing at Pasadena, age eight years; this tree would be of good form if topped. At right, parent tree of the Walker Avocado growing at Hollywood, age fourteen years, the tree showing a very bad form for a cultivated Avocado.

Of the Mexican type many trees may be found scattered all over the southern end of the state, most of which have been grown from seed obtained from Monterey and other points in northern Mexico. The famous Chappelow tree is the oldest and best known of the lot.

Most of these Mexican varieties produce fruits of small size, dark purple in color, but of good quality, and are preferred by many to the large green

fruits, it being the belief that they are richer and of better flavor than the larger varieties.

They are also somewhat hardier than the larger varieties and would probably be valuable in locations where the latter would not thrive.

For home use these varieties will always be desirable, but as a commercial fruit they are out of the question altogether. They are too thin skinned to stand shipment, and would probably not take at all in American markets in competition with the larger, thick skinned fruits.

A few varieties of Mexican origin and green in color are now grown here which are larger than the purple varieties, but these also are thin skinned and of little more value commercially than the purple ones, although the quality is all that could be desired in some cases. To be profitable commercially, the fruit will have to be thick and tough skinned, so as to stand shipment, and as yet no Mexican variety which has fruited here has this quality.

Outside of the Mexican varieties the only other type known to have successfully fruited here is the Guatemalan. The trees of this type are probably all descendants of the old Miller tree, the seed of which was brought from Guatemala and planted at Hollywood over twenty-five years ago. Numerous seedlings have been grown from this tree, several of which are now bearing. The Walker tree is the best known of these, and is the most prolific tree known here, its crop every year running into the thousands. From the behavior of these trees it seems certain that this type is admirably adapted to this climate, a fact of the greatest importance to the future of the industry here.

In his bulletin on the avocado, Collins speaks of the avocados of Guatemala as forming a very distinct group, the most peculiar characteristic of which is the unusual thickness and toughness of the skin, and he considers them the most promising of all types from a commercial standpoint. It is particularly fortunate, then, that this type has been tested here and its adaptability proved, for the way has been paved for the introduction of numerous forms of the type with practical assurance of success. Another noteworthy point in regard to this type is the fact that all of the local trees are spring bearers, this point alone making them of great value. Being spring bearers their blooming season is considerably later than the fall bearing Mexican sorts, so that danger of the crop being destroyed by late frosts is almost eliminated. Already we have several varieties of this type that are well worth growing, of which the Lyon is the most promising, it being the finest avocado yet produced in California, of good size and excellent quality. This variety has just come into bearing, and therefore is little known as yet, but its prolificacy and good qualities promise to place it in the lead of the local varieties. The trees of the Guatemalan type are easily distinguished from those of the Mexican type because more spreading, particularly when young, and the leaves are more lanceolate.

It has been the general impression that the South American type which is grown in Florida would not succeed here, but this remains to be proved.

Budded trees of many Florida varieties are being tested in Southern California, and the Bureau of Plant Industry expects to send out a large number this spring for trial. One large tree at Sherman which was worked over to the Trapp variety flowered this year for the first time, and numerous other trees are becoming old enough to bear and will be watched with interest for the next few years. This type is certainly more tender than the Mexican, but the past few winters have shown that some varieties at least will stand our average winter temperature without injury. Future experience will likely confirm the present belief that this type will succeed in many locations here.

Numerous seedlings of Hawaiian, Cuban, and West Indian varieties have been grown, but as yet these have not come into bearing. Budded trees will have to be tested before anything definite can be said of their adaptability.

It has been stated that the avocado would not succeed in the hot and dry

Figure 2. **At left the parent tree of the Ganter Avocado growing at Whittier, Cal., age eight years; at right the parent tree of the White Avocado, growing at Santa Barbara, age twelve years.**

interior parts of California. Trees are known to have grown without injury as far into the interior as Redlands and Riverside, and have fruited heavily at Pomona and San Fernando, and should be tried at Imperial.

PROPAGATION

BY SEED. This is the simplest method, and the one most practiced in California up to the present time. The seeds of most varieties are obtainable during late summer and autumn, and should be planted as soon after removal from the fruit as possible. It has been found to hasten germination greatly if the seeds are buried in moist sand or sawdust for a period of two to four

weeks before planting. During this time they should be occasionally examined, and when they show signs of germinating they can be taken out and planted in pots. After this treatment they will start to grow very promptly and it has the added advantage that only seeds that are sure to grow are planted, and no labor is wasted. For most seeds a four inch pot is large enough. The seeds should be placed in the pot pointed end up, or in the case of the round seeded varieties, the end toward the stem of the fruit, and about one-fourth of the seed left exposed above the surface of the soil. A good rich soil is essential to the best development of the young plant, and should be kept thoroughly moist, but care should be exercised to avoid standing water in the pots, as this is fatal to either the seed or the young tree. While the young trees should be grown in a warm situation, the direct rays of the sun should be avoided. If the seeds have not been buried in moist sand before planting they will often be slow in germinating, especially if not grown under glass. Many of the seeds planted in the fall in a lath house do not come up until the following spring. After the young trees have made a growth of eight to twelve inches they should be shifted into larger pots or cans, if it is desired to carry them on in this way, or set out in the nursery to be grown until of suitable size to bud.

By Budding. It is only during the past season or two that much attention has been given to budding the avocado in California, although previously a few nursery-men most interested in this fruit had tried it. Having no experience of their own in the budding of this particular tree, most of those who have budded during the past year or two have simply applied the methods they would use for citrus fruits, while a few others have followed the instruction given in various publications by those who have experimented in Florida. In all cases the results have proved the budding of this fruit to be no more difficult than that of the citrus fruits, and when a little more experience has been acquired the operation will be performed with as much assurance of success as with the orange.

For commercial purposes plants are grown in pots until about twelve inches high, when they are set out in nursery rows three and one-half to four feet apart, and fourteen inches apart in the rows. Here they are grown and budded and allowed to remain until of saleable size, when the trees are balled, or transplanted into pots, and allowed to become established before being sold.

The method of budding is practically the same as used for the orange. In regard to such points as the best size of stock and buds, and season for carrying on the work, there has, however, been some uncertainty.

Experiments have been carried out locally on stocks ranging in diameter from about one-fourth of an inch to over one inch, with budwood of all sizes, from the young and tender tops to well matured wood of the previous season's growth. Results lead to the conclusion that for small stocks, such as will be obtained during the first summer's growth of the seedling tree, buds from young wood of the current season's growth are the only ones which will give good results. On older trees, mainly two-year-olds, the

buds from older wood seem to take better, but are liable to drop after taking, leaving a blind bud.

The experience of P. J. Wester, in charge of the avocado investigations of the Bureau of Plant Industry, is unquestionably the most valuable to be had on this subject. Under date of January 4, 1911, he writes me as follows: "In 1906 I published an article in the Florida Agriculturist that has been reproduced in many papers, but which does not now wholly represent my views on the subject. The stock should be the size of a lead pencil, in vigorous growing condition with sap flowing freely, and young budwood,

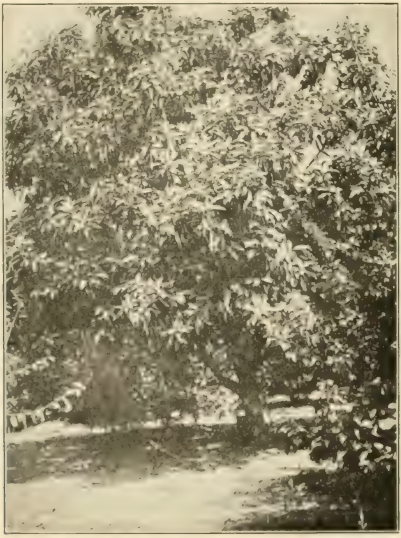


Figure 3. Parent tree of the Harmon Avocado, growing at Sherman, Cal. This tree is thirteen years old, and shows a fine orchard form for an Avocado.

i. e., that from the current year's growth, with well developed buds, used. Do not use old and hard budwood, as such buds after taking frequently drop. Cut the buds large, and cover entirely with waxed tape. The last point may not be so important in California's dry climate. Continued experimentation since I wrote the above mentioned paper shows that budding may be practiced any month of the year, provided the stock is in condition, though for nursery practice I would not bud in August, September, October or November."

Regarding the best season to bud, it seems to be the concensus of opinion here that October and November, which are mentioned by Mr. Wester as undesirable months, are as good a season as any, if not the best of the whole year. This is probably owing to the climatic conditions of Southern California being different from those of Florida.

Three weeks after insertion the buds will have taken and the trees should be lopped back to several inches above the bud. The buds will then start into growth, and when a growth of eight to twelve inches has been made the stock may be trimmed back to the bud.

Edgar Harman, of Sherman, has done considerable experimental budding and what he says will be of value to those contemplating doing this work. The seeds are started under glass and as soon as the plants are two inches high they are set in pots and placed in a protected place in the open. When they have grown to the diameter of three-eighths to one-half of an inch, they are budded. Mr. Harman considers that this operation can be performed successfully any month of the year except July and August. Young and tender budwood is used and the buds cut from three-fourths to one inch long. Waxed cloth is used for wrapping, and the buds are not wrapped very tightly. As soon as the buds swell, which should be in about three weeks, the top of the stock is lopped over at about the fourth leaf above the bud, and a little later on it is cut clear off. When the bud has started into growth the top is cut back to a level with the bud. The sap must be flowing freely at the time of budding to insure success.

C. P. Taft of Orange has probably had more experience in growing and budding the avocado than any other person in California. He says: "I am inclined to regard the months of October and November as the best for budding, though I think there is a short period in the spring when considerable success can be had. The buds I put in my three-year-old orchard last fall have done well and are making a fine growth. About 25% of the buds on stock in cans succeeded. Those put in during the warm summer months were an almost total failure."

In April, 1909, D. W. Coolidge of Pasadena budded about 150 two-year-old seedlings growing in the open ground at Hollywood. The buds were taken from well matured wood of the previous year's growth, and waxed cloth was used for wrapping. Fully 90% of these buds took, but quite a number dropped their buds after having taken. However, fully 75% of the buds inserted developed into trees. Mr. Coolidge has made several attempts to bud stock grown in cans, but with no success, probably because trees thus grown are not sufficiently vigorous.

William Chappelow of Monrovia, owner of the original Chappelow tree, states that he proceeds exactly as in budding citrus fruits, and has budded at all seasons of the year with about equal success.

Large avocado trees which are unproductive should be cut back and budded over to some good variety. The method is simple, and as described has been practiced very successfully by Mr. Harman. The large limbs are all cut back close to the trunk, and the cut ends covered with white lead to

prevent bleeding. In a short time numerous sprouts will make their appearance; all of these should be kept cut off but three or four of the most promising, selected on different sides of the tree so as to form a good head. In a short time they will be large enough to bud, and should be budded in the same way as small seedlings. The wraps must be loosened every four or five days, as the sprouts make a very rapid growth. After the buds have made a growth of several inches the stocks may be cut back and the buds allowed to develop into the new tree. In two years time a good sized head will be obtained.

Figure 4. Avocado tree of the Mexican type growing at Redlands, Cal., showing what the Avocado may become when not pruned or cut back.

The best material for budding tape is cheap cotton cloth which will tear easily. The method of preparing it is described by Mr. Wester as follows: "Rip up the cloth in strips of desired widths, say six inches, and roll these tightly on stout iron wire as long as the width of the strips. Several strips may be rolled on until the roll is one inch in diameter; tie a string around the roll at each end to prevent unrolling while being boiled in the wax. A

good wax is made by boiling together two pounds beeswax, two pounds rosin, and half a pound of good lard; when in boiling state put in the rolls of cloth and let them remain for fifteen minutes, when they are taken out and cooled before being stored away. The iron wire is more desirable than sticks of wood, as the weight of the wire will keep the roll below the surface of the boiling mass. Another advantage in using the wire is that if the sticks are not quite dry the water, as it is converted into steam, will cause the contents to boil over."

Inarching has never been practiced in California, but J. L. Hickson, of Miami, Florida, a large and successful grower of the avocado, states that he propagates entirely by this method, as he considers it produces a stronger and better growth than budding. However this may be, the method is slow and laborious, and trees cannot be produced in sufficient quantities to make it commercially practicable here.

Grafting has been performed successfully in a few instances, but has not been attempted to any great extent as yet.

Cuttings have been very successfully rooted by being placed in clear sand in a lath house, but it is doubtful if this method of propagation produces as strong a plant as the others.

orchard plantings

It is only within the last year or two that orchard plantings of the avocado have been made in Southern California, and then only in very small acreages, but the next few years will see the territory devoted to the culture of this fruit on a commercial scale greatly increased.

The trees may be planted at the same distance apart as orange trees, or if space is available at a somewhat greater distance. Budding seems to dwarf the tree, and budded trees will require much less room than seedlings. In either event the trees should not be allowed to grow to an unlimited size, but should be pruned like deciduous fruits, allowing only the strongest branches to develop and form the head of the tree, and all weak and undesirable growths cut out each year. The top should be kept cut back to facilitate picking the fruit, and not allowed to grow to an unlimited height as has been done with all the seedlings grown here.

Transplanting should be done in early spring, before the trees have started into new growth.

During the first year or two of its growth, the tree is more tender than when larger, and in locations subject to heavy frosts should be protected during the winter by some covering. Palm leaves are used for this purpose if they can be obtained in sufficient quantities, or a frame can be constructed of lath and covered with burlap or cheesecloth. The danger from frost, however, lies not so much in the possibility of injury to the trees themselves, as in the destruction of the crop through freezing of blossoms of early flowering varieties. To avoid this, late blooming varieties may be planted, such as those of the Guatemalan type, which bloom so late in the spring as practically to eliminate all danger from this source. It is only occasionally

that the Mexican varieties are caught, but as the crop is practically certain to be lost, if a very heavy frost occurs during the blooming season, the only safe way will be to plant late blooming varieties.

The tree requires about the same irrigation as the orange. Insufficient irrigation will result in small fruit.

In selecting varieties for planting on a commercial scale, there are a number of points which should be kept in mind. Fruits which ripen during midwinter will command the highest prices in the markets, and there will probably be the greatest demand for avocados at this season of the year. As

Figure 5. At left a Mexican seedling Avocado, eighteen months from seed; at right a budded tree of the South American type, three years from the bud and grown in California.

to size of fruit, there is no advantage in having the very largest. While a two pound avocado is a regal fruit, for practical purposes one of half that size is better. Quality should be one of the most important factors in choosing a commercial fruit, and other desirable points are prolificness, a smooth, thick and leathery skin which will stand shipment, good keeping qualities, and a small seed, completely filling the cavity, as a loose seed pounds the walls in transit, causing early decay. We must, however, have still smaller varieties for cheaper trade, and summer varieties for local consumption, and we already have a good assortment of varieties to choose from for these purposes.

THE FUTURE OF THE AVOCADO IN SOUTHERN CALIFORNIA

It may seem a strong statement to say that within the next quarter of a century the avocado will rank with the orange as a commercial fruit in Southern California. But there is a strong foundation of fact underlying this statement and the reasons seem sufficient, indeed, to warrant the belief that it may become even more important.

First, the adaptability of the avocado to this climate has been proved beyond the possibility of a doubt. There are one hundred or more trees now in bearing, ranging in age from three to twenty-five years, scattered over the southern end of the state from the cool sea coast to the hot and dry interior. These trees embrace a number of widely different types, sizes and characters of fruits. This test of adaptability ought to be sufficient to satisfy the most skeptical.

Second, the food value of the fruit is the main basis for the above statement. It presents in a most easily digested and assimilated form as high as 12 to 18% of fat, which places the fruit in a class with the staple food products, instead of being a mere luxury as is the case with many fruits. The taste for the avocado is not always acquired upon first trial, but a few repetitions are usually sufficient to make any one extremely fond of it. The price is now prohibitive to most, and only a few have had opportunity to acquire the taste, but as the production becomes greater and the price lower, an almost unlimited demand will be created throughout the whole country. It is, of course, universally known as one of the most important staple fruits throughout the tropics and subtropics of the world.

Culture of the fruit in this country will be restricted to limited areas in Florida and Southern California, and consequently the danger of overproduction will be practically eliminated. As rapidly as price and production permit, the avocado will become an important and indispensable part of the daily food of the majority of the people of the United States.

LIST OF VARIETIES

known in California, arranged according to general characters and possible usage:

For winter fruiting: Lyon.

For late fall fruiting: White, Ganter.

For late summer and early fall fruiting: Harman, Fowler, Chappelow, Blake.

For spring fruiting: Walker, Miller.

Large varieties: Lyon, Miller.

Small to medium varieties: White, Walker, Harman, Ganter, Fowler, Chappelow, Blake.

Best varieties for shipping: Lyon, Walker, Miller.

Best varieties for local use only: Ganter, Chappelow, Fowler, Blake, Harman.

Most prolific varieties: Walker, Ganter, Lyon.

DESCRIPTION OF VARIETIES

The following list contains not only those varieties of local origin which have been named up to the present time but is a complete list of all the named varieties in cultivation of which it has been possible to obtain descriptions.

With the increasing number of varieties being propagated every year, it will be absolutely essential to any exact knowledge of this subject that the introducer of any variety shows sufficient differences between the new variety and all previously known ones to warrant giving it a name.

Better Known Varieties

PROVISIONAL KEY TO THE VARIETIES

This key is not to be considered as anything definite for the determination of varieties. It is merely intended to point out the distinguishing characters of the varieties described and supplement the descriptions.

A. Skin smooth.
  B. Towards base broadly rounded; general shape round to oblong.
    C. Skin thick.
      D. Roundish oblate to oblate pyriform; seed more or less loose in cavity ..... TRAPP
      DD. Round to oval; seed tight in cavity ..... SINALOA
    CC. Skin thin; shape oval to oblong.
      D. Averaging more oblong; flesh very rich and buttery; skin glossy; seed not compressed ..... FOWLER
      DD. Averaging more oval; flesh more watery, and not buttery; skin not glossy; seed compressed ..... GANTER
  BB. Towards base more or less tapering, pear shaped, or bottlenecked.
    C. Black, or dark or reddish purple when ripe.
      D. Slender pear shaped, or even banana-shaped.
        E. Skin thin; seed tight; becoming almost black when ripe ..... CHAPPELOW
        EE. Skin medium thick, seed loose; purple with scarlet streaks ..... FAMILY
      DD. Stout pear-shaped; reddish purple; skin medium thick ..... WESTER
    CC. Red mottled with yellow; skin thick; seed tight in cavity ..... CARDINAL
    CCC. Green principally when ripe, in ground color at least.
      D. Without distinct neck; seed loose in cavity; skin thin ..... HARMAN
      DD. With a more or less distinct neck.
        E. Skin thick and tough.
          F. Weight up to 8 5 pounds ..... POLLOCK
          FF. Weight up to 1 5 pounds ..... LANDON
        EE. Skin thin.
          F. Color clear green.
            G. Size small ..... BLAKE
            GG. Size large ..... QUALITY
          FF. Color green, washed with purple; size small ..... WHITE
AA. Skin rough, usually thick.

B. Towards base broadly rounded; pedicel inserted on one side; color dark green ..... MILLER
BB. Towards base more or less tapering, pear-shaped, or bottlenecked.
C. Color deep, dark green; weight up to 1.3 pounds.
D. Length about 4 ins.; pedicel inserted at center; flesh thin..... WALKER
DD. Length about 6 ins.; pedicel inserted on one side; flesh thick..... LYON
CC. Color pale greenish yellow; weight up to 2 pounds..... RICO

Trapp

(Figure 6, A)

Form roundish oblate to oblate pyriform; size medium to large; cavity regular, small, shallow, with gradual slope, somewhat furrowed; stem stout;

Figure 6. At left the Trapp Avocado and at right the Chappelow, as originally figured in Year Book U. S. Dept. Agriculture.

apex slightly depressed; surface smooth and undulating, with numerous brownish dots, some of which are indented; color pale green, with faint and indistinct pale yellow stripes; skin very thick and tough, separating readily from the flesh; flesh fairly thick, firm, but smooth and rather oily in texture, ranging from pale green near the skin to greenish yellow next the seed cavity; flavor mild, pleasant; seed large, oblate, with loose seed coats, and loose in the cavity, sometimes germinating in the fruit when allowed to remain late on the tree, though, so far as observed, without injury to either texture or flavor of flesh; quality very good; season from October 1 to January in South Florida, occasional specimens having remained on the tree in good condition until March.

The tree is reported to be a fairly vigorous grower and very productive.—1906 Yearbook U. S. Dept. of Agriculture.

Sinaloa

(Figures 7 and 8)

Form oval; size medium to large; stem stout; surface smooth, undulating; color light green with numerous large, irregular, brownish dots; skin thick

Figure 7. The Sinaloa Avocado, natural size.

and very tough; flesh rich yellow in color, shading to light green near the skin; texture smooth and very buttery; flavor very rich and nutty; quality very good; seed large, oblate, tight in cavity; season September to October. Originating in Mexico and now in our own plantations.

Fowler

Form oblong to oval, characteristic, length four and one-fourth inches, diameter three and one-fourth inches; apex a dot; base flattened slightly; cavity

regular, small and shallow, flaring; pedicel stout; surface smooth; color light green, with numerous small, rounded, yellowish dots; skin very thin, glossy, adhering closely to flesh; flesh yellow, changing to yellowish green near skin; texture smooth and buttery; flavor very rich and nutty; fibre slight; quality very good; seed medium large, oblong-conical, tight in cavity; season July to October at Pasadena, California.

Tree is of vigorous growth, upright, round topped, with abundant healthy foliage. Rather shy bearer. This is originally described here. A seedling of the Blake, and very similar to the Ganter.

Figure 8. The Sinaloa Avocado.

Ganter

(Figure 9 A)

Form oval to oblong; dimensions, length two and one-half to four inches, diameter one and three-fourths to two and three-fourths inches; apex slightly depressed; base flattened; cavity regular, small, rounded or flaring, slightly furrowed; pedicel very stout; surface smooth, undulating; color

light green, with numerous small, irregular yellowish green dots; skin thin and tender, adhering closely to the flesh; flesh yellowish cream color, changing to pale green near the skin; texture smooth but not very buttery; fibre very slight; flavor rich, nutty; quality very good; seed large, oblong-conical, somewhat compressed, about 25% loose in the cavity; seed cavity medium large; season November to December at Whittier, California.

Tree is a vigorous grower and rather spreading in habit, with abundant healthy light green foliage. A very prolific bearer. Here first described. Very similar to the Fowler.

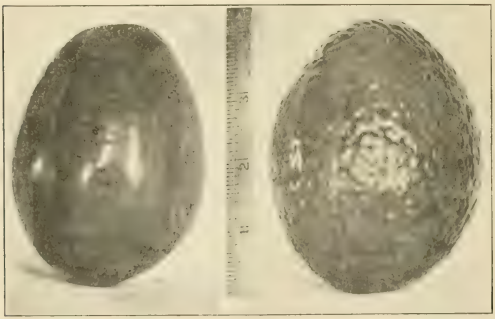


Figure 9. At left the Ganter Avocado, grown at Whittier; at right the Miller, grown at Hollywood.

Chappelow

(Figure 6 B)

Form oblong, slender pyriform or "bottlenecked"; size medium to large for the Mexican type; cavity small, shallow and wrinkled; stem stout; surface undulating, smooth, glossy, color dull purple, with reddish brown dots; apex a mere dot, skin very thin, tender, adhering closely; flesh pale greenish yellow, buttery; seed large in proportion to size of fruit, roundish conical, filling internal cavity; flavor pleasant, though less rich than the best varieties of the West Indian type. Season July to October at Monrovia, California.

The tree is a vigorous, rather diffuse grower, with slender wood. It is productive, although being an early bloomer it is sometimes caught by frost.—1905 Yearbook, U. S. Dept. of Agriculture.

The fruits produced by the original tree show considerable variation in form, and Mr Chappelow states that they are becoming larger as the tree grows older.

Family

A strong growing tree of spreading habits, being an abundant bloomer and moderate cropper. Blooms in late February and during March. Ripens fruit during July, August and September, and into October.

Shape of fruit variable, from pear-shaped to long-oblong, nearly banana-shaped; size, variable from 6 by 3½ to 3½ by 1½ inches; color purple, with scarlet streaks, very attractive; skin medium thick, smooth; stem large; meat yellow, free from fibre; flavor good, seed small, loose in cavity.—*Rolfs.*

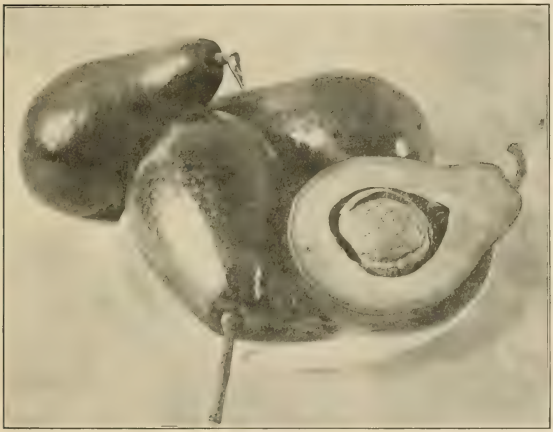


Figure 10. A common Cuban type of large purple Avocados, apparently the same as the Wester.

Wester

(Figure 10)

Form roundish or obliquely pyriform with short neck; average weight 650 grams; skin medium thick, smooth and glossy, adhering to meat; color reddish purple; meat greenish next to skin, rich yellow toward center of fruit; flavor good, rich and buttery; seed medium large, usually loose in cavity; season October.

This variety is of vigorous growth and very prolific.—Bureau of Plant Industry.

Cardinal

Form bottlenecked; skin thick, red, mottled with yellow; flavor very good, a trifle watery; seed small, filling cavity; season October in South Florida.—*Wester.*

Harman

(Figure 11 A)

Form irregularly oval, slightly compressed, and flattened obliquely at the apex; dimensions, length three to four and one-half inches, diameter two to three and one-half inches; apex a dot; base tapering somewhat and slightly flattened; cavity regular, small, shallow, flaring, and somewhat furrowed, calyx persistent in the form of 6 divisions surrounding the stem base of fruit; pedicel stout, insertion usually one sided; surface smooth, glossy;

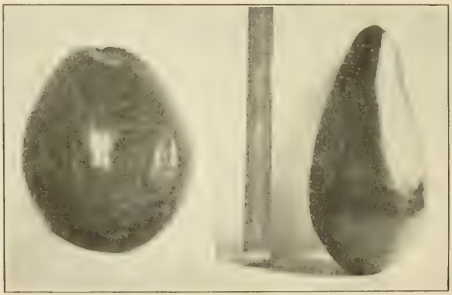


Figure 11. At left the Harman Avocado grown at Sherman, Cal.; at right the White Avocado grown at Santa Barbara.

color light green, washed with reddish purple, with numerous large, irregular greenish yellow dots; skin thin, adhering closely to the flesh; flesh greenish yellow, changing to yellowish green near the skin; texture smooth and very buttery; fibre practically none; flavor very rich and nutty; quality very good; seed very large, roundish conical, often loose in cavity; seed cavity very large; season October to November at Sherman, California.

Tree is upright, round-topped, and of fairly vigorous growth. Foliage rather scant, but healthy. Moderately prolific. This is the first description of this variety.

Pollock

Tree moderate grower, heavy bearer, profuse bloom, limbs rigid; blooms in February and March; ripens in September and October. Upright grower with strong central stem.

Fruit pear-shaped, being about six and one-half by four and one-half inches; weight up to three and one-half pounds; color greenish; rind medium; meat yellowish; flavor good; seed medium.—*Rolfs.*

Landon

Form broad pyriform or bottlenecked; size medium to large, average weight one and one-fourth pounds; surface smooth, undulating; color light green; skin thick and tough, separating readily from the flesh; flesh rich yellow, changing to yellowish green near the skin; texture very smooth and buttery; flavor rich and melting; quality very good; seed medium large, broadly conical, tight in the cavity; season September to October in South Florida.

Quality

Form bottlenecked; size large; color green; skin thin, smooth; quality very good; seed medium large, loose in cavity; prolific bearer; season September in South Florida.—*Wester.*

Blake

Form slender pyriform, bottlenecked; dimensions, length three and one-half to four and one-half inches, diameter one and three-quarters to two and one-fourth inches; apex slightly protruding to form a point; base very slightly flattened; cavity regular, small, very shallow and flaring; pedicel stout; surface smooth, slightly undulating; color light green with numerous small, round, greenish yellow dots; skin very thin, adhering closely to the flesh; flesh creamy yellow, changing to yellowish green near the skin; texture smooth and buttery; fibre very slight; flavor very rich and oily; quality very good; seed medium, conical, often loose in the cavity; seed cavity medium large to large; season September to October at Pasadena, California.

Tree upright, of fairly vigorous growth, with abundant, healthy, light green foliage. Moderately prolific. Here first described.

White

(Figure 11 B)

Form slender pyriform; dimensions, length four and three-quarters, diameter two and one-fourth inches; apex slightly protruding to form a point; base somewhat flattened; cavity regular, small, shallow, rounded, pedicel stout; surface smooth; glossy; color bright green, washed with purple, with numerous small, round, yellowish dots; skin thin and leathery, adhering closely to the flesh; flesh cream color, changing to pale green near skin; texture smooth; fibre objectionable; flavor rather watery; quality fairly good; seed conical, large, tight in cavity; seed cavity long, pointed, and wrinkled; season November to December at Santa Barbara, California.

Tree is upright, moderately vigorous, and a rather shy bearer. First described here.

Miller

(Figure 9 B)

Form oval; dimensions, length four and one-half inches, diameter three and one-half inches; apex a slight point; base rounded; cavity regular, small

and shallow, flaring, furrowed; pedicel very stout, insertion usually one sided; surface very rough; color dark green, with numerous small, round, yellowish dots; skin very thick and tough, separating readily from the flesh; flesh yellowish cream color, changing to yellowish green near the skin; texture, smooth; fibre very slight; flavor fairly rich; quality good; seed large, roundish conical, tight in cavity; seed cavity large; season February to April at Hollywood, Los Angeles, Cal.

Tree is upright, vigorous, with abundant dark green foliage. Moderately prolific. Here described for the first time.

Walker

(Figure 12)

Form broad pyriform; dimensions, length four and one-fourth inches, diameter two and one-half inches; apex a dot; base rounded; cavity none; pedicel rather slender; surface very rough; color dark green, with numerous medium

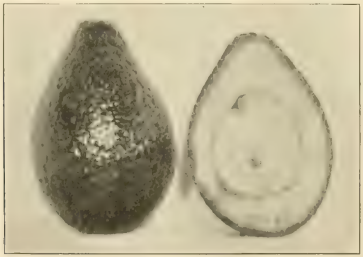


Figure 12. The Walker Avocado, one of the Guatemalan type, one-half natural size.

-sized, round, yellowish green dots; skin very thick and tough, separating readily from the flesh; flesh cream color, tinged with green near the skin; texture smooth, but not buttery; flavor fair, rather watery; fibre objectionable; quality fair; seed large, broadly conical, tight in cavity; seed cavity large; season March to May at Hollywood, Los Angeles, Cal.

Tree is a vigorous grower, spreading in habit, with abundant, healthy, dark green foliage. Extremely prolific. A seedling of the Miller. Here first described.

Lyon

(Figure 13)

Form broad pyriform; dimensions, length five and one half inches; diameter three and one-half inches; apex slightly depressed; cavity almost none; pedicel very stout, insertion usually one sided; surface rough, color dark green, with numerous small, irregular, yellowish or russet dots; skin very thick and tough,

separating readily from the flesh; flesh yellowish cream color, tinged with green near the skin; texture smooth and fairly buttery; flavor rich and nutty; fibre none; quality very good; seed large, broadly conical, tight in cavity; seed cavity medium large; season February to April at Hollywood, Los Angeles, Cal.

Tree is a vigorous grower, upright, with abundant, healthy foliage. Very prolific. This is the first description of this variety.

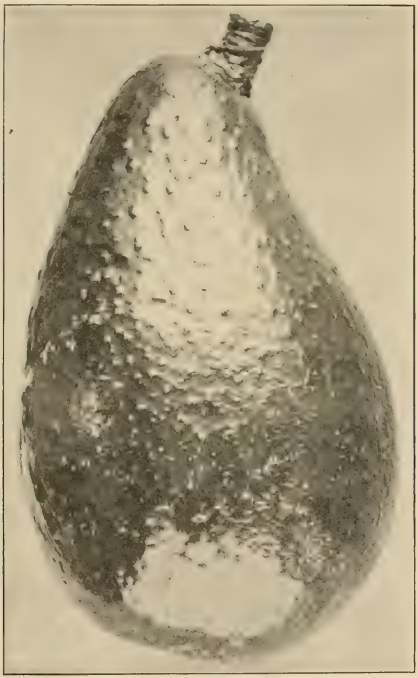


Figure 13. The Lyon Avocado, a fine example of the Guatemalan type. This specimen grown at Hollywood. Natural size.

Rico

Form rather oblong, thick necked, with oblique depressed flattening on opposite sides of both ends; average weight two pounds; skin rough; color pale greenish yellow; flesh pale yellow, with very little green near the skin; texture fine grained, firm; flavor very rich, nutty and buttery; season August to November in South Florida.—*Cellon.*

Insufficiently Known Varieties

Largo

Budwood from Mr. C. H. Matthews, who described the fruit as follows: "Egg shaped, very large, three and one-half to four pounds in weight; skin green, very thin; flavor very good; seed small; ripens in August and September."—*Wester.*

Johnstone

Budwood from Judge R. S. Johnstone, who gave the following description of the fruit: "Pear shaped, but rather broad at basal end; skin smooth, thin; flesh yellow, almond flavored; seed large; famous as the best avocado in the Bahamas. Ripens in August and September."—*Wester.*

Blackman

Form oblong; size medium large to large; color greenish red to chocolate; skin thick and leathery; flesh delicate yellow, soft and melting; seed tight in cavity, medium large; quality good; season September in South Florida.—*Wester.*

Cyrus

Form pear-shaped to round; skin smooth, yellowish, thin, quality good; seed loose in cavity; very prolific; season September to October in South Florida. (Analysis gave 17% fat.)—*Wester.*

Sterling

Skin thick; color dark bronze red; quality good; seed filling cavity, medium large; season October in South Florida.—*Wester.*

Baldwin

Tree a vigorous grower, with strong central stem; branches rather rigid; light bloomer, but heavy cropper. Blooms in February and March. Fruit at best in August; drops in September. Ripens uniformly. Shape of fruit approaching oblong, four by five and one-half inches, not regular; color green, with a few yellowish streaks; rind smooth, thin, stem small; meat deep cream, one-fourth green, firm, flavor excellent. Seeds are rather large, firm in cavity.—*Rolfs.*

Wither-Tip of Citrus Trees

(*Colletotrichum gloeosporioides* Penzig)

Its History, Description, Distribution, Destructiveness, and Control

BY E. O. ESSIG*

HORTICULTURAL COMMISSIONER OF VENTURA COUNTY

Common Names: Wither-tip; Leaf-spot; Tear-stain; Lemon-spot; Anthracnose; Canker.

INTRODUCTION.

The first observations on wither-tip in Ventura County were made by Dr. Albert F. Woods, Pathologist and Physiologist in the U. S. Department of Agriculture, Bureau of Plant Industry, during the month of April, 1909. At that time he made very careful examinations and found that much damage was being done by its attacks. The leaf-spot, lemon-spot, red-spot, dropping and discoloration of leaves, and the dropping of young fruit were all classed as the results of the wither-tip fungus.

Later in August of the same year Dr. P. H. Rolfs, who had done more work on this disease than any one else, visited the orchard and pronounced all of the above forms wither-tip, just as had Dr. Woods. Mr. Powell was of the same opinion, so it was not strange that the management of the Limoneira ranch, where these valuable observations were made, began at once to take steps to not only hold the disease in check, but to prevent the conditions already occasioned by it. The work there has been pushed with much interest and the results to date will be found in this article further on.

During the summer of the year 1910, Mr. C. N. Jensen of the Whittier Pathological Station made several trips into this county investigating this problem, but he did not remain in the State long enough to finish his work. At an inspection of the trouble in the Limoneira orchards he left the impression, to me at least, that this fungus was not in the habit of attacking strong and healthy tissues, but rather those portions of the tree which had become weakened by some external or other internal factor. In a letter from Dr. Coit, of the Whittier Station (following) it is made plain that Mr. Jensen did recognize the fact, that under proper climatic conditions, the disease did attack perfectly healthy trees. However, the impression left was that much of the work on wither-tip control was of little avail and we rather awaited further specific evidences of its work. These came in the form of a very severe outbreak in the Havana Seedling Orange orchard belonging to Mr. N. W. Blanchard of Santa Paula during the months of November and December, 1910. The tops and sides of the large trees were dreadfully injured by the work of the fungus, which killed fruit-bearing-wood back as far as four feet from the tips of the branches. The leaves curled up on the twigs and died before dropping to the ground and much of the fruit dropped within a few weeks.

*Graduate of Pomona College.

Inspection has shown that evidences of the diease could be found in every party of Ventura county. During the month of December, 1910, the navel orange trees of A. Anlauf in Santa Paula canyon showed the same conditions, while most of the lemon trees were affected, as noticed by the experts at the Limoneira ranch.

As soon as the attack was noticed, branches and leaves were taken to the laboratory and the characteristic-fruiting bodies of the wither-tip were obtained in great numbers. Samples were also sent to the Bureau of Plant Industry at Washington and to the Whittier Pathological Station. The replies affirmed the observations taken in the laboratory here and were as follows:

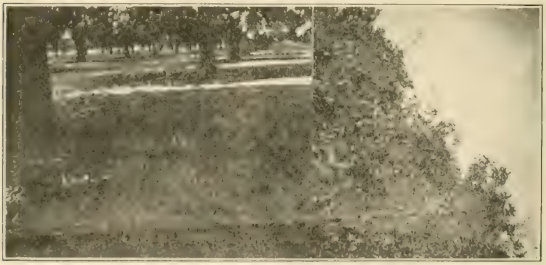


Figure 14. At left showing ground under trees covered with fruit and leaves dropped by the wither-tip; at right, the side of a tree with numerous twigs killed by wither-tip.

"E. O. Essig, *Santa Paula, Cal.*

"Dear Sir: I regret the delay in answering your letter of November 5th. I have been away travelling nearly all the time for the last month and in the meantime, Miss Hasse, my assistant, has made a careful examination of these specimens. They turn out to be typical wither-tip, the fungus *Colletotrichum glocosporioides* being abundant * * * Your experience in having this attack following a series of rains is also the regular thing for that fungus.

"Yours very truly, M. B. WAITE, *Pathologist in Charge.*"

Washington, D. C., Dec. 12, 1910.

"Southern California Laboratory,
"Whittier, Cal., Nov. 7, 1910.

"Mr. E. O. Essig,
"Horticultural Commissioner, Santa Paula, Cal.

"Dear Mr. Essig: Your interesting letter of November 5th and specimens of diseased orange twigs at hand.

"You are quite right in your decision that the specimens represent injury done by the wither-tip fungus, *Colletotrichum gloeosporioides*. I beg leave to differ with you, however, slightly in your statement that the opinion today is that the wither-tip disease does not attack healthy growth. Mr. Jensen, who worked on this disease last spring, maintained that the wither-tip did not attack healthy growth in any part of California except certain situations along the coast where the damp fogs and cold winds from the ocean seem to bring about a condition which permits the fungus to act as a parasite on lemons and oranges. He stated that in two places which he thought wither-tip might become a parasite in California were in the vicinity of Santa Paula and certain limited areas in the neighborhood of San Diego. In fact, he found one place near San Diego where the fungus was undoubtedly assuming a role of a parasite and advised that the trees be sprayed with Bordeaux Mixture.

"We are very interested to learn of the additional case you describe on Mr. Blanchard's trees and would suggest that the logical procedure would be of course to spray with Bordeaux Mixture.

"Would be glad to hear from you in the future in regard to developments.

Very truly yours,

"J. Eliot Coit, *Acting Superintendent.*"

With all of the past experience with wither-tip behind us and with the added features already described we felt that immediate measures should be taken by all to hold this disease in check. The present article, aimed for the general public, is to set forth, as clearly as possible, the seriousness of a problem which we may all of us have to face, and which many of us are facing at the present time. Every possible bit of information has been collected and included in the article so as to make it as thorough as our present knowledge will allow. I am quoting very liberally from Mr. H. Harold Hume, Prof. P. H. Rolfs and Mr. H. S. Fawcett, all of whom have written valuable information concerning wither-tip. All correspondence relative to the subject has been included and in this shall be found much of the latest in investigation. Mr. J. D. Culbertson, Assistant Manager of the Limoneira ranch, has taken the time to give us the history and present status of the work which has been, and is being, done there. Combining our own observations, we trust that some value may be had from this first publication.

HISTORY AND DISTRIBUTION

The fact that the wither-tip had existed as a serious citrus pest in other places first led progressive growers to fear it in this country. At the present time it is known in practically every citrus growing section in the world in spite of the fact that many hold that it can do damage only where certain moisture conditions are secured.

Of the general distribution Prof. Rolfs states, "The disease extends through a large portion of Florida, the West Indies, South America, Australia, and Malta. In Florida the diseases seem to be increasing in severity." Prof. L. M. Underwood wrote: "This disease was found at only one point in Lake

county (Florida). Dr. Martin found it in 1886 at Green Cove Spring. It does not seem to be widespread nor at present of much importance, but is recorded here that attention might be called to it, so that its nature might be known and its progress watched."—Jr. of Mycol., VII.; p. 35, 1891.

"Professor Hume has collected specimens of the disease in several places in Florida. He also mentions that some pomelo seedlings lost nearly all of their leaves as a result of the attack of the fungus in question." "Miss Stoneman found that this fungus attacked orange trees in conservatories." "Penzig mentioned this fungus as being destructive to citrus plants, attacking the foliage mainly." "McAlpine found this fungus on the orange near Melbourne, Australia, in 1892, and in 1898 it was found by Tryon to be destructive to the lemon leaves in Queensland." "In Brazil it seems to be quite generally distributed. Noack found it especially severe at Sao Paulo, where it was recognized not only on the leaves, but also on the smaller twigs, latter were killed as far as the fungus penetrated, showing a very decided demarcation between the sound and diseased areas." U. S. Dept. Agrcl. Bull. No. 52, 1904, p. 10.

"This disease on the fruit was first observed by the writer in the autumn of 1901, but attracted little attention at that time, as the damage was slight, only a few specimens of the diseased fruit having been observed in a single grove. Since that time the disease, in the grove where it was first observed, has increased to such an extent that the trees, on which it was first noticed, yielded a very small proportion of sound fruit during the present season. The disease has probably been at work for a considerable length of time, and as is usual in such cases, attracted little attention until it became serious. The loss during the past season in two or three instances has amounted to from five hundred to a thousand dollars in a single grove."

"From our present knowledge of this disease it appears to be on the increase and we are probably justified in predicting that it has not yet reached its worst. The disease is in all likelihood an introduced one and it may be looked to, to attack the sweet orange in addition to the lemon, lime and pomelo. It frequently occurs upon leaves, twigs and branches of the sweet orange, and on one occasion sweet orange fruit on one of the fruit stands in Lake City, Florida, were observed, covered by lesions (diseased spots) caused by this same fungus *Colletotrichum gloeosporioides*." H. H. Hume, Fla. Exp. Sta., Bull. No. 74, pp. 161-162, Aug., 1904.

In view of the fact that the disease is thought to do damage only in a damp or moist climate, it might be interesting to state that the writer recently spent a week in the Salt River Valley, Arizona, looking over the citrus orchards and especially as to the distribution and damage caused by withertip. Of course it was at a damp period of the year, but cannot be compared to the favorable places Dr. Coit quoted Mr. Jensen as pointing out to be favorable to the severe attacks of the disease. The fruit growers of that section stated that much of the bloom and young fruit had been dropped by some mysterious manner—frost they believed to have been the cause though it had come some time before the real damage was done. All of their

descriptions pointed to wither-tip as we saw it in Ventura County, and the matter was followed up as carefully and as fully as time would permit. The results were that under the trees were to be found quantities of the discolored leaves so common to the attacks of this disease, while the familiar leaf spot was seen everywhere. Bare twigs and dead branches showing the acervuli (fruiting bodies) were also very common. Perhaps not all of the dropping of the young fruit, referred to, was caused by wither-tip, but, from the indications, it is more than likely that a great loss was due to it. Even the indications in the discolored leaves, leaf-spots and bare twigs are interesting from so dry a country as Arizona and only goes to show that the disease may thrive and do well in any climate where there is a rainy season.

In California. In this state the disease may be found in practically every citrus growing section, but it is not contended that it has been doing damage in all. In Ventura County, the writer has collected specimens of the leaf-spot in all parts, including those sections furtherest away from the coast. As stated before the fungus seems to thrive best in the vicinity of Santa Paula in spite of the fact that lemon groves are situated much nearer the coast and are subject to more cold and dampness at Oxnard than at this place. No serious attacks on the orange trees have been noticed at Ventura which is situated right on the sea border.

DESCRIPTION

On the Leaves. (Figs. 15 and 16): The presence of the fungus is best told by its appearance on the leaves. The most common forms are leaf-spots which show up while the leaves are still clinging to the tree and appear to be healthy in every other way. The spot is usually light brown to nearly colorless and is surrounded by a very characteristic brown ring, which separates the dead from the living tissues of the leaf (Fig. 16). Arising upon the dead discolored spot are numerous minute dark acervuli (fruiting bodies of the fungus). The spots may begin at any point of infection and spread so as to run into each other almost entirely destroying the texture of the leaf. They may start at the tip-end or at an edge and cut out deep margins. It appears that this condition is brought about by the fact that after the infection started the leaf was able to retain enough vigor to resist the attacks, so that the diseased areas only were killed, instead of the entire leaf succumbing and falling off as is usually the case.

This latter form is perhaps the most common indication of wither-tip on the lemon trees. The leaves first turn a sickly yellow color, gradually become brown and fall to the ground. Many may fall while still in the yellow state, while large numbers have been collected and the wither-tip obtained from them, which were still green when they fell. Not a few leaves may be found which begin to turn brown at the tip (Fig. 15) the infection working backwards to cover the entire surface before the stem is reached and severed.

On the sweet and navel orange-trees the infestation is very marked and sudden. The leaves die, curl up and turn a greenish-brown color while

still hanging to the twigs. Entire twigs may thus be affected and the foliage does not fall until it is thoroughly dead and dry. One can always tell this stage by the dark color of the leaves.

In all cases of doubt as to whether wither-tip is in an orchard or not, it can be accurately demonstrated by placing the leaves or twigs, supposed to be infected, into a moist chamber and within three or four days the cinnamon-brown acervuli (Fig. 15) will appear on all surfaces in great numbers.

Figure 15. At left a lemon leaf showing darkening area by incipient wither-tip; at right the magnified surface of an orange leaf covered with numerous acervuli of wither-tip, each one of which contains great numbers of spores.

Of the leaf-spot H. H. Hume writes in Bull. No. 74, Fla. Agrcl. Exp. Sta., p. 164, Aug., 1904. "On the leaves, the disease first appears in the form of rather irregular areas from one-eight to three-fourths inches across. Occasionally they become confluent or join each other so as to embrace a large portion of the surface of the leaf. The spots vary in color from bronze-yellow to a dark shade of brown, depending upon the stage of development. Usually the diseased spots are located near and extend to the margin of the leaf. The tip is quite a favorite seat of infection, the lesions (diseased

spots) may, however, be located on the leaf entirely removed from the margin. The characteristic color noted above marks the commencement of the disease, the period during which the mycelium (fungal threads) is growing most actively in the tissues of the leaf."

"As the disease progresses, the affected area becomes more clearly defined. The areas representing a number of separate spots of infection, close to each other, becomes continuous. The color changes from yellowish to the gray hue of dead tissue. The line of division, between the dead and the green, living tissues, is slightly elevated and as already noted, clearly defined. At this stage, a close examination of the discolored spots on the upper side of the leaf reveals the presence of a number of minute dark dots. These dots are arranged more or less completely in concentric circles or ovals.

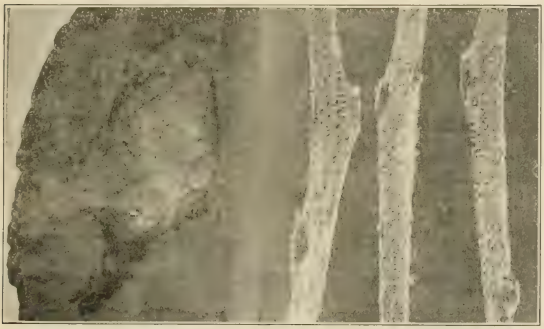


Figure 16. At left a characteristic leaf spot of lemon probably also due to wither-tip; at right fully developed acervuli of wither-tip on orange twigs.

These dark dots are in reality the spore-bearing parts of the fungus (Acervuli) containing large numbers, the spores, by means of which the disease is spread from one portion of the tree, from one tree or from one grove to another. The affected, or diseased areas are usually located near the tip or side of the leaf, though they may be situated near the central portion of the blade."

Of this leaf-spot Prof. Rolfs says, "The first point of attack is in the leaf. The development of the fungus takes various peculiar forms. At times the acervuli are distributed in a more or less irregular way from the center, resembling 'fairy rings.' At other times the infection takes place in the tip of the leaf, which gradually withers back to the stem. Small trees may be defoliated and the fungus continue to develop in the twigs." U. S. Dept. Agrcl. Bull. No. 52, p. 15, 1904.

On the Twigs. (Fig. 16): The twigs on the Havana Sweet orange trees at Santa Paula often died back as far as did the leaves, but in most cases they first remain green but bare for some time after the leaves have been killed and dropped. Fig. 10 shows a branch nearly four feet long which was entirely killed on the tree before the leaves dropped. This condition is especially true of the smaller outside twigs on the orange trees. This dying is accompanied by the same unhealthy discoloration described in the leaves, the tissues dividing the dead from the healthy portions assuming the characteristic brown ring. No spores appear upon the twigs until after they have been dead for some time and are subjected to a moist condition. In the moist chambers of the laboratory the fruiting bodies were

Figure 17. Spots caused by wither-tip on lemon; the same on orange to the right.

produced upon all of the dead tissues (Fig. 16) and upon the apparently healthy green portion of the twigs 12 inches below the ring, showing that the disease was working back all of the time and simply awaiting a condition favorable for another outbreak.

The twigs of the lemon trees do not succumb to the attacks of the disease as rapidly as do those of the orange. They remain bare for a long period, and though green and healthy looking do not bear leaves or fruit. So far as worth to the tree is concerned they might just as well be dead. In time they do turn brown and dead from the tips back, the infection usually

stops at a fork in the branch. The lemon trees, showing the effects of the disease most, are those which have the greatest number of fallen leaves and bare twigs.

On the Fruit. (Fig. 17): The fruit-spot, commonly called lemon spot, orange-spot, and pomelo-spot or anthracnose is the most easily recognized. On the lemon it usually develops in the packing house and is first simply a dull green blotch, remaining so after the lemon has turned yellow in curing. Later the center of the spot, which may enlarge, becomes from a sickly-yellow to a brown color and is softer than the margins, which have retained the same firmness as the rest of the lemon. This stage develops the black or dark brown acervuli, which appear in the center of the spot, giving it a dark color. The tissues begin to sink, forming a depression in the center of the spot. The fruit may keep in good condition when thus infected for a long time without any apparent progress in the work of the fungus and again it may decay very rapidly. The green spot may not develop to form the fruiting stage until after the lemons have been placed upon the market, so may admit of the marketing of the fruit, but it places it in the lowest grade.

It will be interesting to note that many have considered this spot a result of sweating and not a fungus at all, but it is the wither-tip brought out, perhaps, in greater abundance, by sweating, than under normal conditions, which has given rise to this belief.

The so-called "red-spot" (See Fig. 18) on the lemon has never been described outside of California. However, it has received considerable attention from Dr. Woods and Prof. Rolfs—men who are the best authorities known on wither-tip. These men have all pronounced it as a result of this fungus.

The infection takes place at any point on the rind in the form of minute dark brown or cinnamon red spots. At first these may be so small that they cannot be detected without the aid of a hand lens and may be very scarce. The spots grow in size and increase in number until the whole rind is speckled. Later they become confluent and spread over the entire surface giving the fruit a dark-brown or even black appearance. The disease does not seem to affect the pulp of the fruit at all, but simply disfigures the rind so as to make it unfit for market. Each red spot, in the earlier stages, produces a sunken area which is very characteristic of this stage.

The attack is more often on the fruit known as "tree-ripes"—fruit that has ripened on the tree—but it is not an uncommon thing to find it also abundant upon the green fruit. It was first noticed on the trees affected with "Gummosis," and it has not infrequently been attributed to that as a cause. It may be that it was most abundant here because of the weakened condition of the tree, brought about by the gumming, which enabled the fungus to find the most favorable conditions for growth.

Of the spot Dr. Woods writes: "Before leaving California I arranged with Mr. Powell to have a lot of the lemons and grapefruits showing the tear-stain and browning and other effects of the wither-tip fungus forwarded to

me. I had these carefully examined and found the fungus, *Colletotrichum glocosporioides,* present in practically all cases."

Concerning the same point, Mr. M. B. Waite, Pathologist in Charge of the Bureau of Plant Industry, Washington, D. C., writes: "In the first place there is no question about its (the disease on lemon twigs and fruit sent to Mr. Waite for determination) being affected with the wither-tip fungus, *Colletotrichum.* Spots were found with a little of the fungus on microscopic examination and upon culture tests the material was found to contain considerable of the fungus. Ripe spores were found on old, dry twigs, while the leaves and the fruit developed spores after being sterilized and covered with a dry bell jar."

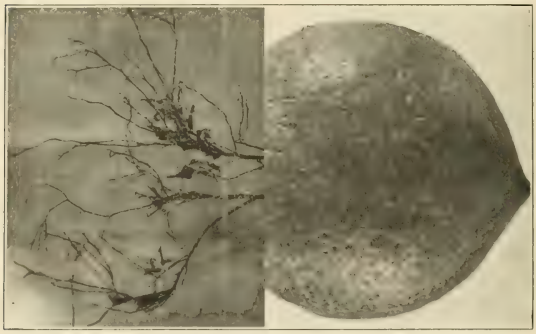


Figure 18. An orange branch killed by the wither-tip, some of the dead leaves still hanging; a lemon showing red-spot caused by wither-tip.

"I think the red spider is responsible for the spread of the fungus to a considerable extent on the lemons this season, the slight injury produced by the spider making an opening for the fungus to get into the skin of the fruit."—*P. H. Rolfs.*

On the orange the first symptoms appear as greenish or brownish irregular blotches, resembling greatly those described on the lemon. These spots grow rapidly while the fruit is still on the tree and may assume nearly half the size of the fruit. (This being due to the fact that many spots become confluent thus forming a single large diseased area. The average size, however, is about that of a 25c-piece.) With age the center of the diseased area may become lighter before turning a dark brown or black with the appearing of the dark fruiting bodies. The area may be raised above the remaining surface of the orange or it may sink to form a depression as is shown in the photo (Fig. 17).

Mr. Hume gives the following about the disease on the fruit of the pomelo: "Upon the fruit the disease is first manifested by the irregular brownish discoloration. This discolored area is irregularly defined around the margin. The diseased spot may be on any portion of the fruit and may vary from an inch or so in diameter to an area nearly equal to that of the outside of the fruit. As it progresses these spots gradually change in color, sometimes becoming grayish, sometimes somewhat lighter. Ultimately, however, the whole affected area becomes dirty black in color. If the point of infection is small at first it gradually enlarges under favorable conditions so as to embrace the whole fruit. Sometimes the affected area remains constant in size for a considerable time, in which case in its older stage it varies from black at the center through various shades of brown, brownish yellow to the normal yellowish color of the healthy rind at the margin." Fla. Agrcl. Exp. Sta. Bull. No. 74, pp. 165-166, Aug., 1904.

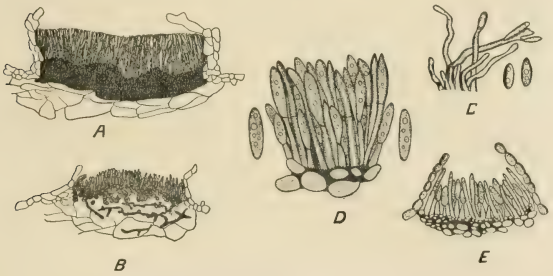


Figure 19.

Details of fruiting bodies of wither-tip fungus: A, acervulus with compact contents of setae, conidiophores and conidia (original); B, acervulus in more advanced stage, the spores escaping (original); C, conidiophores, conidia and setae (after Hume); D, enlarged portion of B; E, cross section of acervulus after McCullough in Bull. 52, U. S. Dept. Agrcl.

SPECIFIC DESCRIPTION

This fungus is strictly parasitic, e. g., feeds directly upon the tissues of the host plant. The conidia (spores) are very minute regularly oval bodies which are admitted into the tissues of the host by means of small punctures or abrasions of any kind. Here they germinate, forming rather stout mycelium, which penetrates the plant cells, and through which the fungus draws all food. Not until the tissues of the plant are killed are the acervuli (fruiting bodies) produced. These acervuli contain the conidia or spores which develop within the little sac. As soon as they are produced from the mycelium they shove themselves through the surface of the host and when the conidia are ripe the top opens up allowing them to escape.

There are millions of these conidia formed within each acervulus. (Fig. 19 A, B.) As stated above the spores (Fig. 19 C, D, E) are oblong or oval, but much longer than the diameter. In mass they appear cinnamon brown or even dark, but under the lens they are apparently colorless, containing minute granules and several oil globules, as shown in the figures. They are formed as small buds (conidia) upon the ends of short conidiophores and break off very easily when mature. There may be seen all stages of these forming conidia and conidiophores in a single acervulus, but all will mature before the fungus has finished its mission in life. It is not over-stepping the mark to say that each acervulus may produce many thousands of spores, all of which will germinate under favorable conditions. The acervuli may be produced upon any surface of a twig, fruit, or leaf in numbers sufficient to prove that the mycelium has penetrated every cell beneath. (Fig. 19 B.)

Prof. Rolfs' technical description is as follows: "Acervuli located on the surface of the leaf, twig, or fruit; 90-270 u in diameter, erumpent, superficial. Shape various, not uniform, occuring on either surface of citrus leaves; disposed irregularly or in more or less concentric lines; pale to dark colored. On tender lime twigs, tender lemon twigs, lemon fruits, and lime fruits, pale colored, dull red in masses, confluent. Epidermis breaks irregularly."

"Setæ fuliginous, ranging in length from 60 to 160 u, frequently once or twice septate, disposed at margin of acervuli. Frequently absent, and on tender lemon twigs, tender lime twigs, lemon fruits, and lime fruits usually absent."

"Conidia broadly oval or oblong, 10-16 u by 5-7 u, hyaline; size variable in same acervulus, usually with one or two oil drops. Developing from a well defined stroma; basidia, 3-8 u. In moist chamber the conidia stream from the break in the epidermis."

"Intra-basidial setæ, variable 8-30 u by 3-6 u, cylindrical or sometimes enlarged at distal end; hyaline."—U. S. Dept. of Agrcl. Bull. 52, p. 16, Mar., 1904.

DESTRUCTIVENESS

As has been stated before, the first appearance of the disease upon the orange, in a serious way, was upon the foliage and especially on the fruit-bearing wood for the next season, although much of the present bearing wood was completely killed and the fruit fell to the ground. The photograph (Fig. 9) will give some idea of this attack. It will be seen that the leaves have died in patches all over the outside of the tree. The bare twigs at the top shows an earlier attack which dropped all of the leaves. Figure 18 A shows a branch taken from the top of a sweet orange tree a week after the infection was first observed upon the tree. Figure 14 A shows a typical case of fallen leaves and fruit. This photograph was taken under the tree shown in Figure 14 B a week after that photograph was taken. It will give some idea of the severity of the disease and an idea of what it means to an orchardist.

Not all of the fallen fruit show the effects of wither-tip at the time it dropped, but if placed away in moist chambers soon develop the spots described above. The infections are quite general on much of the fruit that has not fallen and the amount of injured fruit may reach to several hundred boxes, not counting what may develop after it has been picked and boxed for shipment.

The fact that the infection takes place before any evidence is displayed upon either tree or fruit makes the pest a serious menace if one has not been prepared to meet it in advance. All fruit which has become infected on the tree cannot be treated in any wash that will prevent the coming out of the fruiting bodies. To demonstrate this, leaves infected in the orchard were soaked a short time in Bordeaux Mixture, such as is used for spraying citrus trees, and placed in the moist chambers. The acervuli appeared in great numbers through the residue of the Bordeaux upon the leaf. All methods of control must be directed as preventive. This makes the results of the first unlooked for attack very destructive to the orange grower. It is well to dip the fruit, however, to prevent infection in the box or in the packing house.

The leaf-spot—"Canker"—is more common upon the lemon than upon any other citrus tree in this county. In Florida it seems to work to even a greater degree upon the pomelo, but such a case has not been observed here yet. Neither have we ever found the withering of the twig and leaves as described by Prof. Rolfs on the lemon tree. The discolored leaves, the spot, and the bare twigs give us the most evident clues in the field.

It is the dropping of the young fruit that is considered the most serious work of the fungus in the lemon orchards. At times it seems as if a third of the young setting lemons were dropped by it. The brown mummies on the ground or still clinging to the trees are full of the wither-tip spores. Much of the work being done at the Limoneira ranch is to prevent this condition. The results and costs, as well as the importance of the work there is to be presented in Mr. Culbertson's paper further on. Concerning the dropping of the bloom due to wither-tip, Prof. Rolfs states:

"The most serious shedding of bloom occurs as the result of an attack of a parasitic fungus, *Colletotrichum glocosporioides*. This is a serious trouble, for only too frequently its cause is not recognized, the shedding of the bloom being ascribed to one of the before-mentioned causes, or to the presence of thrips or other insects.

The first sign that we notice in connection with the wither-tip dropping of bloom is that a great number of unopened flower-buds have fallen from the tree. As this same effect may be the result of other causes, the mere fact that we find unopened flower-buds on the ground should not be considered as proving that we have a case of wither-tip bloom dropping. Upon closer examination, however, we find that where the bloom has dropped on account of being affected with the wither-tip fungus, there are little red markings upon it; and the buds or blossoms may be partially, or even entirely, covered by these red patches. By examining such flower-buds or

petals in the laboratory it can be easily demonstrated that they are affected by the wither-tip fungus. By using a strong hand-lens one is able to see the minute pustules in which the spores are produced. Such diseased flower-buds and petals, however, differ so strikingly from those that have fallen naturally, that almost every one whose attention has been called to the point is able to distinguish between them, without the aid of a lens. When much bloom has dropped as a result of being affected with the wither-tip fungus, one almost invariably finds the typical signs of wither-tip on the tree. The most prominent of these are the dying back of small sprigs, and the very characteristic want of leaves on the inside of the tree. Whenever one sees a tree in the orchard that has no interior foliage, it should be noted as a suspicious specimen.

The wither-tip fungus which causes the dropping of the flower-buds lives over the winter in the leaves, or in the twigs of the tree, or on fallen fruit. From these sources some of the spores find their way to an open bud, where the fungus grows very rapidly and produces myriads of spores. Bees, flies and other honey-loving insects, visit the affected blossoms, and coming into contact with the fresh spores, not only carry them on their bodies to almost every open blossom on the tree, but in crawling over the unopened buds they convey the spores to these as well. But worse still, the insects which have visited an infected tree carry the spores to other trees in the grove, and from these secondary infections numerous other infections occur in time; so that hundreds of trees that were free from the wither-tip fungus may become infected from one single tree with diseased blossoms.

DROPPING OF NEWLY-SET FRUIT

Sometimes this fungus does not attack the bloom, but attacks the newly-set fruit after the blooming period is over. Not unfrequently one may see the ground under a citrus tree strewn with thousands of small fruits, every one attacked by wither-tip fungus. In this case the same remedy used for the shedding of bloom will be found useful." Fla. Agrcl Exp. Sta. Press Bull. No. 84, Mar., 1908.

The large fruit spot described under the heading "Description" (Fig. 5) shows up to a considerable degree in the packing houses. In the past little attention has been given to it except to cull all infected fruit and run it into the lowest grade. While many of these lemons go down before shipment the bulk remain sound enough to reach the eastern markets. The principal injury is due to the fact that fruit, which would be first grade except for the spots, is rendered almost worthless for selling purposes.

The "Red-spot" usually appears in the field and all infected fruit is culled out by the time the fruit is ready for the pack. It has the same valueless feature as has the lemon-spot in rendering the fruit unfit for market. The fruit infected with this spot keeps very well, for only the rind is injured. I have in my office a lemon preserved from last year, the rind of which is entirely browned due to the red-spot, but the inside of which is

perfectly sound and in excellent condition. The occurence of the trouble is sufficiently great to warrant considerable expense in preventing it.

LITERATURE AND SYNONYMY

Colletotrichum gloeosporioides Penzig.

Vermicularia gloeosporioides, Penz. Funghi Agrumicoli. No. 90, p. 66, Padova, 1882.

Phyllosticta adusta, E. & M. Jour. Mycol. II, p. 130, Nov., 1886.

Colletotrichum gloeosporioides Penz. Botanici rumi e sulle piante affini, Ann. d'Agris, p. 384, 1887.

" adustum E. Jour. Mycol. VV, p. 35, May, 1891.

" gloeosporioides Rolfs. U. S. Dept. Agrcl. B. of Pl. Ind., Bull. No. 52, Mar., 1904.

" " Hume. Fla. Agrcl. Exp.. Sta. Bull. No. 74, Aug. 1904.

" " Rolfs. Fla. Agriculturalist. 32, p. 130, Mar. 1905.

" " Hume Cirt. Fruits and Their Cult. pp. 473-475, Dec. 1907.

" " Duggar. Fung. Dis. of Plants, p. 327-328, 1909.

" " Cal. Cul. 32, p. 708, June 1909.

" " Cook. Cal. Cul. 33, p. 460. Nov. 1909.

" " Fawcett, Fla. Agrcl. Exp. Sta. Press Bull. No. 133, Dec. 1909.

" " Massee. Dis. of Cul. Pls. and Trees. p. 144, Jan. 1910.

" " Fawcett, Cal. Cul. 34, p. 725, June 1910.

" " Cal. Cul. Pruning 35, pp. 660-661, Dec. 1910.

CONDITIONS FAVORABLE TO GROWTH

Any climatic condition unfavorable to the growth of the tree is liable to bring on an attack of wither-tip, especially in a country which has been subject to this attack.

Frosts kill the twigs of the trees and afford excellent places for the fungus to germinate and produce spores.

Wind.—Hard winds whip the trees so as to cause numerous abrasions and wounds, which afford excellent entrances to the spores of the wither-tip.

Insects.—Perhaps no better condition is afforded for the infection of the plant tissues than that due to the attacks of insects. Scale pests constantly draw sap from the trees, and the slightest rain washes the spores down the limbs and into their punctures. It might be expected that this disease would be worse in dirty orchards than in those which are kept perfectly clean.

Diseases.—Gummosis has certainly had something to do with the production of the "red spot" so often referred to. As has been stated, the two conditions have been associated together as arising from a common cause. The

spot is probably caused by the weakening of the tree due to the gummosis rather than any other reason. It might naturally be expected to find the wither-tip upon any diseased trees which are suffering from Gummosis, Die-back, Foot-rot, etc.

Lack of Care.—Poorly fed trees have been observed to succumb to this disease first—the leaves showing the spots, the twigs dying, and the fruit spotted before it appeared elsewhere. The cure is obvious.

Moisture.—This is perhaps the most important factor in contributing to the growth of this disease. As with all of the fungi a moist condition produces ready and rapid germination and excellent conditions for future growth. The early observations of the wither-tip were all connected with the belief that it could thrive only in a very moist climate. This belief caused some surprise to the Florida experts who thought that the climate in California was too dry.

The attack in Ventura County was preceded by an unusually heavy rain which brought on the attack almost immediately.

It will probably be found in any citrus growing community which receives any rainfall at all, from the fact that it has been observed in Arizona, but only during the winter months.

In a wet country much trouble must be expected from this disease.

A systematic application of sprays should be continued throughout the year, in plots at least, so as to be sure of the advantages of the preventative work of fungicides.

TREES ATTACKED IN VENTURA COUNTY

SEVERE ATTACKS:

Variety	*Location*
Havana Sweet Seedling Orange	Santa Paula.
Navel Orange	"
Valencia Oranges	" and Saticoy.
Eureka Lemons	"
Lisbon Lemons	"

Slight Attacks.

All citrus trees in this county.

MODES OF DISTRIBUTION

Wind.—The spores are so minute that when they become dry they may be carried for miles by the wind. These spores are usually blown into the tops of the trees and the heavier attacks may be expected in these places. In Southern California it must be expected that, if the disease is common along the coast, that the coast winds are sure to carry the spores to all inland sections and these need only the moisture conditions to produce the disease.

Water.—If the spores find lodgment in the tops of the trees they are sure to be carried to all parts of the undergrowth by the first rain. This is the most effectual way of infecting all parts of the tree. The "Tear stain" is produced by the dripping of the water from an infected twig or "Mummy" to an uninfested lemon.

Insects.—Prof. Rolfs attributed much of the red-spot to the work of the red spider, and this indeed is a very important factor in the scattering the spores on the leaves and fruit as well as a means of inoculating those portions of the tree. Other insects as young black scale, plant lice, as well as the silver-mite, prove efficient distributors of this disease.

General Articles on Wither-tip.

Of the disease in California the California Cultivator states: "This disease has been quite severe on citrus trees in some parts of the state. Last November it occurred in a number of groves near DeLand, causing much damage. It killed back twigs and limbs even in otherwise healthy and well-kept groves. It was noticed, in some cases, that the damage done by wither-tip became evident after several weeks of dry weather following a period of moist weather. It was also noticed that in a neighborhood where groves were close together, the disease would frequently be severe in one grove while at the same time a neighboring grove would remain free from it. Within the same grove also there were individual trees and individual limbs of a tree that were attacked, while other trees of the grove and other limbs of the diseased trees remained uninjured. The difference in the action of the fungus toward different limbs of the same tree is probably due to a difference in the vitality of the individual limbs. Any cause rendering a branch somewhat weak, such as previous heavy load of fruit, would most render that branch susceptible to an attack of the fungus. The same would doubtless be true in regard to the susceptibility or immunity to the disease of the different trees in a grove. Cases occur that can be accounted for by considering trees as individuals, each slightly different from the other. One tree apparently just as healthy as another is, for some cause, not yet understood, less resistent to this particular disease, and is therefore attacked, while the tree next it may remain uninjured."—Cal. Cul. XXXII, p. 708, June, 1909.

The condition, as stated above, is no doubt a common example of the attack of the wither-tip, but such was not the case in the orange orchards at Santa Paula. The trees were in excellent condition, with plenty of fertilizer, water, and cultivation. There had been no frosts, and no hot weather to weaken the trees or branches. A rain fell about three weeks before which started the spores germinating and an attack resulted which did not omit even the healthiest-looking and most vigorous trees. It was a case where every tree was touched without regard to its vitality.

Prof. Cook of Pomona College writes: "During the last two or three years a new disease has appeared in our citrus orchards. It is the old well-known wither-tip of Florida. It attacks all kinds of citrus trees. It is probable that it is affecting many orchards without being known or recognized at all.

The disease pits the fruit; causes the leaves to fall, and the terminal twigs to wither. In some orchards it has done serious harm and would have become very much more serious had it not been discovered and the remedy applied."—Cal. Cul. XXXIII, p. 406, Nov., 1909.

The History and Control In the Limoneira Orchard

BY JAMES D. CULBERTSON,* ASSISTANT MANAGER

"During the summer and fall months of 1908 we became suspicious of a new and strange trouble affecting the lemons in the Limoneira orchard. It was evidently a fungus, and although confined mostly to the ripening fruit, nevertheless the incipient stages were plainly noticeable on many of the half-grown lemons that were still green. Of the ripe fruit a great many of the lemons were rendered unsalable and thrown away, while thousands of others were thrown into the lower grades by the disfigurement resulting from this "rust" or "brown-speck" as some called it. On the greener fruit it appeared as tiny black specks, like minute pin-pricks, while on the half-ripe and ripe lemons these specks were usually a reddish brown, and many of them had increased in size varying from the smallest speck visible under a hand-lens to the size of pock-marks, or even larger. Each spot formed a marked depression in the rind, and not infrequently they would merge into one another until in some instances covering the entire lemon, leaving only a brown "mummy" hanging where the healthy yellow fruit had been. Traces of this trouble had been noticed off and on for several years, but the amount of fruit affected by it was so insignificant in relation to the whole that its presence at first occasioned not even a comment, so that it is not known when it made its first appearance.

By the spring of 1909, however, we began to realize that the percentage of infected fruit was a commercial consideration in itself, not to speak of possible future increase in loss. The new crop was being gathered from the trees and everywhere throughout the 300-acre orchard the presence of this trouble was more evident than ever. Specimens of affected fruit were sent to various sources for identification. Trees containing the worst affected lemons were usually below the normal in vigor of leaf and twig, and often chloratic and subject to gum disease. In some cases we wondered if this first trouble could be a part of the cause, as we later learned that it was. But on even the healthiest trees it was nearly always possible to find some of both the green and yellow lemons affected with the characteristic minute spots.

While waiting for reports on the specimens sent out it happened that Dr. A. F. Woods, then Assistant Chief of the Bureau of Plant Industry, and Mr. G. Harold Powell of the same Bureau, were making a trip through Southern California and paid us a visit. It was the 20th of April. When taken to the orchard, without hesitation, they pronounced our trouble "wither-tip", scientifically known as *Colletotrichum gloeosporioides*, a fungus parasite of Citrus known and dreaded in Florida for 15 years. While we had noted only its effects on the fruit our attention was called by these gentlemen to numerous dead twigs, to yellow and brown spotted leaves, and also to countless small blackened and dried lemons that had probably been attacked and killed by the fungus, when otherwise healthy, before they were larger than small beans. These were characteristic of "wither tip" ravages in Florida, and the presence

*Graduate of Pomona College

of the acervuli on dead twigs and leaves, together with frequent brown stains, "Tear-stains", on the fruit, further convinced them that our trouble was the same.

They were surprised that in the dry climate of California the fungus could thrive and propagate itself so vigorously. Dr. Woods and Mr. Powell both assured us that it could be checked by fungicides, particularly mentioning Bordeaux Mixture with Bicarbonate of Soda, but they were of the opinion that its present development in the orchard was probably abnormal, due perhaps to extraordinary weather, for we had had a warm winter with more than the average amount of humidity. With the return of dry summer weather they thought it would make little or no further progress and probably would cause no anxiety in the future except possibly during seasons similar to the one just passed. Accordingly we did nothing at the time other than to send samples of twigs, fruit, and leaves to Washington, together with a request for all available literature on wither-tip, particularly Bulletin No. 52, by P. H. Rolfs, treating of the disease in Florida. The edition of this bulletin was completely exhausted, but a later appeal to Dr. Woods, who had returned to Washington in the meantime, brought the following reply:

"Washington, D. C., May 29, 1909.

Mr. James D. Culbertson, *Santa Paula, California.*

My dear Mr. Culbertson: I have your letter of May 21st. relative to your failure to get the wither-tip bulletin. I was very sorry to find on my return to Washington recently that this publication had been entirely exhausted and that there was no copy to be had either from the department or from the Superintendent of Public Documents. A new edition will have to be printed.

Before leaving California I arranged with Mr. Powell to have a lot of the lemons and grapefruits showing tear-stain and browning and other effects of the wither-tip fungus forwarded to me. I had these very carefully examined and found the fungus, *Colletotrichum glocosporioides*, present in practically all cases. I explained to you, this fungus, which produces diseases of various names, such as anthracnose, wither-tip, canker, lemon-spots, tear-stain, etc., lives perennially in the twigs of the diseased trees. Infection of the twigs is known to take place through the flowers, through injury to the foliage, the fruit, and stems, by insects or otherwise. I think the red spider is responsible for the spread of the fungus to a considerable extent on the lemons this season, the slight injury produced by the spider making an opening for the fungus to get into the skin of the fruit.

(For control see same under that heading.)

Very truly yours,

A. F. Woods,

Physiologist and Pathologist and Assistant Chief of Bureau.

Through the courtesy of Mr. G. W. Hosford in investigating the careful handling of lemons under the direction of Mr. Powell we obtained a few days' use of a private copy of Bulletin No. 52 referred to above. A typewritten copy of this Bulletin put us in possession of sufficient data to direct

us in some experimental tests against the fungus. Apparently it was increasing in the orchard, both on twigs and fruit, especially affecting the young lemons just setting from the bloom.

Within two days the most startling evidence of what wither-tip may do to an orchard impressed itself upon us. In one of the healthiest of the grove we suddenly discovered that half of the leaves had fallen from the trees so recently that many of them showed no evidence whatever of wilting. For a few days the petioles still clung to the tree. Some of these fallen leaves were turning brown beginning usually at the tip and extending down the midrib while others contained irregular yellow-green spots of irregular shape. A slight jarring of the boughs by the hand precipitated still more leaves, apparently vigorous and healthy, save for the pale yellowish-green spots described above.

The next day, June 5th, 1909, we had one of our power spray outfits in the field and sprayed three small groups of trees with the following:

FORMULA NO. 1.

Resublimed sulphur	1¾ lbs.
Sodium Hydroxide 98%	1¼ lbs.
Water	50 gals.

This we prepared by first passing the sulphur through a fine sieve and adding just enough water to make a thick soup. To this we added the pulverized caustic soda, stirring vigorously to prevent burning. After a few minutes the sulphur was almost entirely dissolved. The solution was then strained directly into the spraying tank which already contained the extra 50 gallons of water. This amount treated 7 trees.

FORMULA NO. 2. SELF-BOILED SULPHUR

Resublimed sulphur	8 lbs.
Unslacked lime	8 lbs.
Water	50 gals.

This we prepared as per directions given in Circular No. 27. (See under heading of control.)

This quantity sprayed 8 trees.

FORMULA NO. 3. BORDEAUX MIXTURE

Bluestone	5 lbs.
Unslacked lime	6 lbs.
Water	50 gals.

Eight trees required all of the 50 gallons.

Of course we knew that we could not expect to save the leaves and twigs already affected and that any results from the spray might not be clearly noticeable for months. The presence of black scale and more or less red spider in the orchard suggested the possibility of a spray combining both the merits of a fungicide and an insecticide. Accordingly we sprayed another set of rows, adding to each of the above formulæ 2S Beaume spray distillate in sufficient quantity to make the mixture contain 2½% distillate.

Formula No. 1, the sodium sulphide spray with the distillate added, seemed superior to either of the others, practically eliminating the red spider and promising high efficiency against the young scales. Occasional burns on the fruit where a drop would collect and evaporate, and slight injury to the young growth and lemons just setting, were more than offset, as we thought, by its greater efficiency against spider and scale. Four power sprays were soon at work covering the orchard at the rate of about 6 acres per day. They were at work steadily for nearly three months and our expenditure exceeded $3,000 or more than 11c per tree. Our faith in this combination was supported also from the following letter from Mr. R. C. Allen, of the Sweetwater Fruit Company, San Diego Co., California:

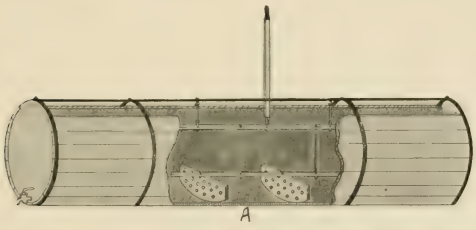


Figure 20. Tank for receiving lime after it has been slacked and is ready to mix with copper sulphate. The agitator is the special feature of this tank.

"Bonita, California, June 16, 1909.

"MR. JAS. D. CULBERTSON, *Limoneira Co., Santa Paula, Cal.*

Dear Sir: We have your letter of the 11th in regard to spraying with sulphur. This is no new thing with us, as we have been using it systematically for the last ten or twelve years. We use about 10 pounds of sulphur to the 200 gallon tank. We dissolve the sulphur with at least half as much caustic soda, our method being to moisten the sulphur first and then add the soda and heat over a fire, being careful not to let it boil over. Some people get satisfactory results without the fire, but we do not.

It may be some advantage to use caustic potash instead of soda for the reasons you mention. But so far as it affects the tank, or upon the hands of the sprayers is concerned the caustic principle in the potash or soda is entirely exhausted in fusing the sulphur. We advise the use of a good grade of sublimed sulphur in preference to the ground. The latter contains a good deal of impurities and is much more difficult to dissolve.

We have hitherto used galvanized tanks on our spraying machines but we have recently bought a bean outfit which has a wooden tank. As we have used the same iron tank for 5 or 6 years and it is still in good condition, you need not fear any trouble on that score.

I think it is practical to use the solution for circulation in the water jacket, but it will require to be cleaned out occasionally, and probably will not be as satisfactory as where clear water is used.

We have been in the habit of dissolving about 50 pounds of sulphur at a time, using a galvanized iron wash tub, and making our fire at any point where it is most convenient to mix the material, but I believe it would be better to have a central place for boiling, using a large cauldron.

In regard to the effectiveness of this spray on the "wither-tip" I am not wholly sure, though I have great faith in it. We are preparing to begin at once using the Bordeaux Mixture on part of our orchard. Simply enough to demonstrate whether there is any advantage in its use over the sulphur sprays. I think that we have seen "wither-tip" years ago upon grapefruit without in the least realizing what it was. During the years when we sprayed with sulphur it disappeared. But for the past three years we have been fumigating with the consequence that not only the "wither-tip" but red spider, and even a little silver mite, have begun to reappear. So that in any event a sulphur spray has become a necessity.

I have not yet noticed any such dropping of green leaves in our orchards as you speak of. I should be very glad indeed to have you send me the bulletin on "wither-tip."

Very truly,

R. C. ALLEN."

Instead of sodium sulfide spray we used the potassium sulfide, obtained in the same way except that caustic potash was used as a solvent instead of caustic soda. We believed that its value as a fertilizer over against the negative value of the sodium as a soil constituent more than justified its use even at a considerable increase in cost. This will explain Mr. Allen's reference to the caustic potash.

The sudden dropping of leaves mentioned of one portion of the orchard extended more slowly to the entire orchard. June 17, 1909, I made the following note: "Through lower half of orchard wither-tip generally distributed."

July 12.—Prof. P. H. Rolfs, Director of the Florida Agricultural Experiment Station and author of the Government Bulletin No. 52 on wither-tip, addressed a meeting of the Southern California Lemon Men's Club at the Chamber of Commerce in Los Angeles. He had spent a few days looking through the orchards in the vicinity of Los Angeles and Whittier where he found the fungus generally distributed. He considered it hardly necessary to spray for the twig withering as he found it here, but he did advise the spray for the leaf-spot and lemon-spot, as these manifestations of the fungus result in loss of foliage and fruit. Florida experience in later years had proven that the Bordeaux Mixture as weak as 4-4-50 solution was preferable to any other spray known.

Two days later Prof. Rolfs visited the Limonera orchard. Like Dr. Woods and Mr. Powell, he was surprised that the fungus has been able

to gain such a foothold in so dry a climate. On his advice we discontinued the sulfids sprays and began with a 3-3-50 Bordeaux and distillate mixture on the remaining third of the orchard.

It may be well to state here that the application of the distillate with the fungicide did not in the end do as efficient work as we at first thought it would. With the Bordeaux its killing power seemed almost entirely lost.

No further spraying of the orchard as a whole was attempted until Nov. 1910, but in Jan. 1910 and again in June, 1910, one ten-acre plot was thoroughly sprayed with the Bordeaux, leaving as a check four rows through the middle unsprayed. Careful watch was kept on the fruit and trees in all parts of the orchard. During a full year subsequent to the general spraying of the orchard as recounted above, there seemed little difference between the sprayed and unsprayed trees. The former always seemed darker green and possibly set their fruit a little better, but we could not be absolutely certain on these points. Perhaps as Rolfs suggested, we were enjoying a non-infectious period such as is often very evident in Florida.

With the removal of the older lemons that were affected at the time of the first spraying there was left little evidence of the fungus either on leaf or twig or fruit. But in September and October, 1910, the minute reddish brown speck on the fruit and the pale green or yellow spot on the leaf began to show soon after an unusually heavy early rain. By the first of November a trace of it could be found on almost every tree. Occasional leaves had already dropped.

On the ten-acre plot that had been given the two extra sprayings with Bordeaux it is difficult even at the present time—Jan., 1911—to find the least trace of the fungus in active development except on the four rows left unsprayed. There it is easy to find it on both leaf and fruit, though not as yet seriously injuring either. The difference conspicuous at a glance is sufficient to convince us that there is great promise in prompt and thorough treatment at the right time of the year. Just what time and just how often is yet to be definitely determined.

We began spraying this time with a 4-4-50 Bordeaux, on Nov. 12. Three-fourths of the orchard has been treated. Under the trees first sprayed only the leaves already badly affected at the time have fallen since, while trees not yet sprayed have in some portions of the orchard carpeted the ground with leaves, and every shake of the boughs adds to their number. We are exercising great care in the matter of check rows, leaving several in every section of the grove that we may know with certainty the merit of our work and its value in regard to the time of application.

The conclusions are more or less tentative—we are not sure that we can prevail much against the fungus when weather and tree conditions favor it, but from results thus far apparent from spraying we are sufficiently convinced to spend another $3000 this season in combating it with Bordeaux.

Whether or not the following facts have any pertinent significance in this discussion may be a matter of question, but it is nevertheless of interest. Our

winter and spring crop of lemons for 1910 was nearly 50% short of the previous year's crop during the same portion of the year, while the 1910 summer crop was the greatest summer crop we have ever produced. The lemons that were picked this last summer came from blosoms that followed immediately the fungicide spraying of the year before. Other factors may have contributed to this result, yet it may be that the spraying was not the smallest factor as is evidenced by Prof. Rolfs in his article on Citrus Bloom Dropping. (See under lemon below heading of Destructiveness.)"

METHODS FOR CONTROL

The methods used in the control of this fungous parasite must necessarily be preventative. After the disease is once established in the tissues of the host it can never be destroyed without destroying the host also, because it works within the tissues, and until the acervuli appear upon the surface to expose its conidia or spores for distribution, it is protected by the epidermal layers of the host.

Many methods have been recommended. It may be that certain measures taken in some localities may prove impractical in others, while a combination of all may be successful in special cases.

We shall take up the discussion, then, under the following heads: Spraying, Pruning, Orchard Practice (to include Cultivation, Irrigation and Fertilization), and Packing House Methods.

SPRAYING

In all the work that has been done with sprays in combating the withertip, the Bordeaux Mixture stands out as the most efficient, and we are wont to give it the first place in this consideration.

The formula now used at the Lemoneira orchard is known as the 4-4-50 or,

Unslacked lime	4 lbs.
Copper sulphate (bluestone)	4 lbs.
Water	50 gals.

The task of mixing these chemicals, where so much of the spray is used, is no small thing in itself. A great deal of study has been given to the construction of suitable mixing apparatus.

The first consideration is to get the materials high enough on a platform so that they can be easily and rapidly placed in the spraying tanks of the power machines. This is done by constructing, at convenient places in the orchard, platforms large enough to hold a large box for slacking lime, a lime solution agitator, and a vat for dissolving the bluestone. Such a platform is about 12×12 feet square and 4½ feet high. A large standpipe for filling the tanks is a necessity or the water must be pumped into the tank while the solution is being added.

The lime is first slacked in a common vat for that purpose. The great trouble has always been to keep the slacked lime agitated properly when it was being drawn off to mix with the bluestone in the spraying tank. This problem has been met with a special agitator for this purpose (Fig. 20).

The lime from the slacking vat is strained into this tank through the slanting bottomed strainer (Fig. 21 B). The agitator works by means of a hand lever and the contents of the tank may be thoroughly mixed in a few minutes before it is drawn off for use. Here it is again strained through the strainer shown in Fig. C, as well as is the bluestone.

The bluestone vat is simply a box containing slats, across the entire box as shown in Fig. 21 D, or simply across one end. These slats must be low enough so that the bluestone, contained in sacks, which is placed upon them will be completely immersed in the water used as the solvent. This method admits quick dissolving of the bluestone, much more rapid than if simply poured into the tank and stirred.

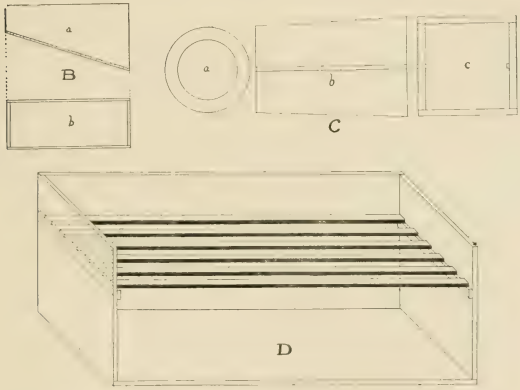


Figure 21.
B, slanting-bottom strainer for straining lime into sprayer tank; a, a side view, the screen nailed on a slant at bottom, and b, top view showing shape of box; C, round wire sieve for straining lime into sprayer tank, a, the wooden bottom with hole covered with wire screen, b, cylindrical sides made of fine wire screen tacked around the round bottom and square top, and c, top of strainer; D, box for dissolving bluestone, this being placed on the slats in sacks and under water.

The lime and bluestone are mixed with a given amount of water so that the proper quantities of the resultant solutions can be measured so as to give the mixture the strength of the above formula.

The sieve used should be made of brass wire and contain 20 meshes to the inch.

Mr. Culbertson stated very clearly that the Bordeaux Mixture has given them very satisfactory results. His experience had been extensive. He has used many other sprays, but has discarded all for the Bordeaux.

Prof. Rolfs makes this statement regarding Bordeaux:

"The loss from spotting of lemons may be greatly reduced, if not entirely prevented, by spraying with fungicides, such as potassium sulphid, ammonical solution of copper carbonate, and Bordeaux Mixture."—Bull. 52, U. S. Dept. Agrcl., p. 17, 1904.

SELF-BOILED LIME-SULPHUR MIXTURE

Among other sprays recommended by Dr. Woods and tried out by Mr. Culbertson was the Self-boiled Lime-Sulphur Mixture of the following formula:

Unslacked lime	8 lbs.
Resublimed sulphur	8 lbs.
Water	50 gals.

The self-boiled lime-sulphur mixture is a combination of lime and sulphur boiled with only the heat of slacking lime and is primarily intended for summer spraying as a substitute for Bordeaux Mixture where the latter is injurious to foliage or fruit. For most purposes Bordeaux Mixture is the better fungicide, and should be used except when likely to injure the plants treated * * * The self-boiled lime-sulphur mixture, however, when prepared as a mechanical mixture with lime and sulphur with only a small percentage of the sulphur in solution, is not injurious to peach foliage, and in our experiments for two years past has proved to be a good fungicide.

The mixture can best be prepared in rather large quantities—say 20 pounds, or even 40 pounds, at a time—so as to get enough heat to produce a violent boiling for a few minutes. Place the lime in a barrel and pour on enough water (about 3 gallons to 20 pounds) to start it slacking and to keep the sulphur off the bottom of the barrel. Then add the sulphur, which should first be worked through a sieve to break up the lumps, and finally enough water to slack the lime into a paste. Considerable stirring is necessary to prevent caking at the bottom. After the violent boiling which accompanies the slacking of the lime is over, the mixture should be diluted ready for spraying, or at least cold water added to stop the cooking. Five to fifteen minutes are required for the process, according to whether the lime is quick acting or sluggish. The intense heat seems to break up the particles of sulphur into about the physical condition of precipitated sulphur, and the violent boiling makes a good mechanical mixture of the lime and sulphur. Only a small percentage of the sulphur—enough to improve the adhesiveness of the mixture—goes into solution, but if the hot mass is allowed to stand as a thick paste the sulphur continues to unite with the lime, and at the end of thirty or forty minutes enough of the reddish liquid is produced to burn peach foliage and even apple foliage in some cases. Hence the necessity for cooling the mixture as soon as the lime is well slacked. The finely divided sulphur in mechanical mixture with the lime is depended upon for the fungicidal action rather than the sulphids in solution, the latter being harmful to foliage except in very dilute form.

The mixture should be strained through a sieve of 20 meshes to the inch in order to remove the coarse particles of the lime, but all of the sulphur should be worked through the strainer.

The amount of water required to make the best mixture depends largely upon the lime. Some grades of lime respond quickly and take a large quantity of water, while others heat up slowly and are easily "drowned" if too much water is added at once. Hot water may be used to good advantage in preparing the mixture with sluggish lime, but with quick acting lime hot water is not necessary and is more likely to bring too much of the sulphur into solution. If desired, the mixture may be kept for a week without deterioration, but should be thoroughly stirred before using.

In applying the self-boiled lime-sulphur mixture the spraying outfit should be equipped with a good agitator. The mixture settles to the bottom of the tank, and unless kept thoroughly agitated cannot be evenly applied. For a power sprayer the propeller type of agitator is most suitable. The agitator of the ordinary barrel sprayer is not unusually adequate and when used should be supplemented with frequent hand agitation."—U. S. Dept. of Agrcl. Circ. No. 27, pp. 5-6, 1909. W. M. Scott.

Regarding this mixture Dr. Woods wrote Mr. Culbertson:

"Of course, we have not tried these mixtures on oranges and lemons, but Mr. Scott suggests that the mixture made of 8 pounds of sulphur, 8 pounds of lime, and 50 gallons of water would be the best for this purpose. This would probably control the wither-tip and to a considerable extent prevent the development of the sooty mould following aphis and scale."

POTASSIUM OR SODIUM SULPHID SPRAY

As recommended by Prof. Rolfs in Bull. 52:

FORMULA

Flowers of sulphur	30 lbs.
Caustic soda (98%)	20 lbs.
Water to mix	20 gals.

Dilute four quarts of above mixture to 50 gallons of water.

Place 30 pounds of flowers of sulphur in a wooden tub large enough to hold 25 gallons. Wet the sulphur with 3 gallons of water; stir it into a paste. Then add 20 pounds of 98% caustic soda (28 pounds should be used if the caustic soda is 70%) and mix it with the sulphur paste. In a few minutes it becomes very hot, turns brown and becomes a liquid. Stir thoroughly and add enough water to make 20 gallons. Pour off from the sediment and keep the liquid as a stock solution in a tight barrel or keg. Of this solution use 4 quarts to 50 gallons of water.

Important.— (In regard to the use of this spray in California see the letter from Mr. R. C. Allen of San Diego County, in Mr. Culbertson's paper. Also see what Mr. Culbertson says about this.)

The potassium sulphid is made as above only when diluted for use add 1 ounce of stock solution to 2 gallons of water.

AMMONICAL SOLUTION OF COPPER CARBONATE

"Put 3 gallons of water in a wooden or an earthen vessel, pour 3 pints of ammonia (26°B.) in this, and stir it to mix the two evenly. Take 8 ounces of copper carbonate and shake it into the ammonia water, stirring the liquid for awhile. If a considerable part of the copper carbonate remains undissolved, the liquid may be left to settle; if, however, nearly all of the copper carbonate is dissolved, more of it should be added in the manner previously described until a considerable amount remains undissolved; then it is set aside, as stated before. After the precipitate has settled, use the clear blue liquid. The undissolved copper carbonate may then be treated with more ammonia and water, fresh copper carbonate being added whenever the residue becomes less than an ounce. The solution should not be kept for more than a day or two, and when used one gallon should be diluted with 15 or 20 gallons of water."—Prof. Rolfs, in Bull. 52, p. 17, U. S. Dept. Agrcl., 1904.

This spray has never been given a test in this county, but during the present spring extensive tests will be made by this office as well as many other fungicides not yet tried.

PRUNING

Because of the fact that the fungus has never killed the limbs of the lemons outright and it was difficult to ascertain just which wood was infected, the matter of pruning has never been taken up. Then, too, the disease was so general that the possibilities of eradication or control seemed hopeless by means of so slow a method.

The pronounced attack upon the orange trees was so great that the cost of pruning would far exceed anything in the form of sprays.

The fact that the disease had never shown up to any degree upon the twigs before makes it seem to us that pruning would do little good on such large trees. However, in consideration of the facts presented so strongly by Prof. Rolfs and Mr. Fawcett in regard to this method, some checks are to be made to test this advice.

If fungicides applied to the diseased twigs are capable of holding the disease in check and prevent its spreading, we can save much by their application over pruning.

It would be useless to attempt to prune it out of a lemon orchard, where, as stated above, the point of infection on the limbs cannot be definitely ascertained, because only the discolored leaves, spotted fruit and dropped bloom are the only indications. If future observations are able to show just where the infection takes place on the lemon trees as it does on the orange, pruning may be resorted to.

Winter Pruning for Wither-tip is well described by H. S. Fawcett, in Press Bull. 133, Florida Agricultural Experiment Station, December 11, 1909:

"Wither-tip is one of the worst fungus diseases of citrus trees in Florida. In the winter season, diseased trees may be distinguished by the yellowing and falling of their leaves, the dropping of their fruit, and the dying of

their twigs and branches. A citrus tree affected with wither-tip will begin to lose its inside leaves. The outer leaves then turn yellow and fall, leaving many bare and discolored branches. The fruit also drops, with or without spotting.

HOW TO PRUNE

The important thing in pruning is to cut out enough of the wood, in order to get rid, not only of the bare branches, but also of all the branches that show even a slight sign of the disease. In severe cases of wither-tip, there are seen, in addition to bare branches, many limbs on which the yellowish leaves are about to fall. Close examination will show that the disease is slowly making its way back and poisoning these limbs. This poisoning may start from an infection at the tip, or from an infection on a side branch lower down, from which the poisonous effect has spread to the main limb. Sometimes only one side of a tree, or only one branch, is severely affected; while the remaining part of the tree is uninjured. Whatever may be the conditions, it is important to get rid of these poisoned limbs. All limbs that show the beginnings of the disease must be taken out. Drastic measures must be employed, and many bearing limbs may have to be sacrificed. To prune only half-heartedly may make matters worse, rather than better. When pruning, care should be taken to make smooth cuts, usually at the base of a branch or limb, so as not to leave any projecting stubs, in which infection is almost sure to start again. After pruning, paint the larger cut surfaces with carbolineum or pine tar.

The grove should be given unusual care after a severe pruning of this kind. It should be fertilized, so as to bring about a vigorous healthy growth, and to render the trees resistant to further attacks of the fungus.

WHEN TO PRUNE.

Winter pruning for wither-tip should be done between the middle of December and the middle of January. It is important not to delay the work beyond this date. Do not prune while the new growth is putting out, for this is almost sure to result in injury rather than benefit. Begin the work at once, and do not consider the looks of the trees, but take out everything that shows the presence of the disease.

The beneficial results already obtained on hundreds of acres of groves treated in this way, under the direction of Experiment Station workers, have proved the effectiveness of this treatment."

To this we may add the advice given by Prof. Rolfs, in Bull. No. 52, 1904, page 18:

"In a small orchard, or in the case of an isolated tree, especially in a young orchard, much good can be done by cutting out the diseased twigs and picking off the diseased leaves. Where this is practiced with thoroughness the disease can be reduced to a point where it does only a small amount of damage, or it may be eradicated; but pruning and picking must be done at frequent intervals and very thoroughly. This would probably be an effective method of keeping the fungus under control in the case of small orange and pomelo orchards.

Where pruning is practiced the weak limbs are taken out. The spurs that have dropped their leaves are also cut out, and in this way much of the hold-over wither-tip is removed. All wood that has withered is also taken away. This pruning reduces in a large measure the number of spores left in the grove and hence greatly diminishes the extent of infection."

In a letter to Mr. Culbertson, Nov. 18, 1909, he states:

"Under another cover I am forwarding to you my bulletin on Wither-tip, also Hume's bulletins on Citrus Troubles and Anthracnose of the Pomelo, and enclosing you a separate on Wither-tip. This you will notice, was printed several years ago. At the present time we lay more stress on pruning, than on the use of fungicides."

The following article by an unnamed contributor in the California Cultivator, Dec. 29, 1910, pp. 660-661, may be of interest:

"Experience so far has taught us that the only true and sure way to cure wither-tip is by thoroughly pruning. Running over and half pruning usually does as much harm as good. When pruning great care should be taken to saw or cut as close to the base or trunk of the tree as possible, and to make smooth cuts and by all means do not leave any projecting stubs. This precaution should be carried out to the letter, because diseases from these stubs are almost certain to occur when wither-tip fungus is present.

Another thing of great importance is cutting the branches close to the tree as the cut surface soon heals over, leaving a nice smooth body; also if the trees are to be washed, or doctored, it can be executed in one-third of the time, besides it adds beauty to the trees * * *

In pruning for wither-tip great care should be taken to remove every limb or branch that is diseased, as it is important to get rid of all poisoned branches and prevent the disease from spreading. Wither-tip can be distinguished in various ways—namely, as the limbs or branches on the outside turn dark brown and the outside bark will continue to get darker until they are dormant, while the inside bark near the body of the tree will keep continually falling and the leaves will turn yellow, and in a short time the limbs will be bare. Trees that die from this disease soon become very brittle and rot in a short time. When the trees are taken with wither-tip, if the fruit is on the tree, it can be noticed by the fruit dropping to the ground."

The combined testimony of these writers seem to show that pruning is a very important factor in handling this disease in Florida. It might be that we should waive the cost of so great a task and get to work in our California orchards, but it can hardly be brought about until the present methods of using Bordeaux Mixture fails and makes it necessary to resort to the more tedious, laborious and costly means.

ORCHARD PRACTICE

Cultivation.—It has been made very plain by all authorities that a weakened condition in an orchard, under certain conditions is liable to bring on an attack of wither-tip. That this is true cannot be doubted.

Every possible means should be exercised to keep the orchard in excellent physical condition. As cultivation is a very important factor in this work it should receive its full quota of attention. In groves subject to this disease the soil should be stirred deeply enough and often enough to insure all that is demanded from it by the tree.

Irrigation.—The first attack brought on in the Blanchard orchard was believed, by us, to be occasioned by a lack of water. This belief was substantiated by the fact that the ravages of the fungus stopped shortly after the water was applied. That this was not the seat of the whole trouble was demonstrated by the fact that later the best cared-for portions of the same orchard were likewise infected.

A starved condition of the tree cannot be brought about more effectually than to cut off the water supply. Thus such a condition favors the attacks of the disease. It is not necessary to warn watchful growers against this state of affairs for it is a condition not desirable in any grove.

Fertilization.—The lack of fertilizers might cut off the food supply and have a tendency to bring on wither-tip, but it is not in this regard that I wish to call attention to this point. It is what Prof. Rolfs has to say in this regard: "In choosing fertilizers to aid in warding off these diseases (various stages and phases of wither-tip) a large percentage of potash should be used in the compound. The source of potash does not seem to be important, but sulphate of potash has proven a general favorite among growers of citrus fruits.

Sulphate of ammonia is somewhat slower in acting than nitrate of soda, but gives a firmer leaf. Nitrate of soda will produce a very quick growth and a large leaf, but these are especially subject to the attack from the fungus unless well balanced by a generous supply of potash. Organic ammonia in the form of dried blood, cotton-seed meal, and bone meal should not be used in combating this trouble, as it is very likely to produce die-back in addition to the softening of the wood, and so lay the tree doubly open to attack."

A very interesting observation was made in the Blanchard orchard in connection with the use of nitrate of soda. Last year an application of 9 pounds per tree was made in three applications. In previous years only 6 pounds per tree at two applications was the most ever given. It is strange that following the heavier application came the only severe attack of the wither-tip known in this orchard. It is not claimed that this was the cause, for the fertilizer had been used previously without bringing the disease, but might it not have something to do with the seriousness of the attack? Had there not been severe attacks in other orchards, which had received no nitrate of soda at all, this belief would have been well founded. The attacks have been general and the first severe ones noted in the orange groves in this county.

PACKING HOUSE METHODS

It is interesting to know that the "red-spot" does not cause infection of other fruit in the packing house. To demonstrate this Mr. Field, manager of

the Limoneira Packing House, made a great number of tests. He bound clean and healthy lemons to those affected, wrapped them together and placed them in a moist tent where infection would take place readily. The operation was repeated a great many times at various periods, but in no instance was the infection contagious.

The "canker" or fruit-spot shows up among the lemons to no little degree in the packing house, though greatest care is exercised in the washing of the fruit. The common treatment is to add one pound of bluestone to every 1000 gallons of water in the washer tank. This is renewed from time to time to keep the proportions fairly even. If the tank is treated in the morning with a fresh supply of the bluestone about one-half the amount is added to the same solution at mid-day.

Mr. Hume states that "many shippers wash their fruit before shipping it. Ammonical Solution of Copper Carbonate may be added to the water used in washing. Another good substance for this purpose would be Potassium Sulphide."—Bull. No. 74, Fla. Agrcl. Exp. Sta., p. 172, 1904.

A Biological Expedition to Southern Mexico

BY D. L. CRAWFORD*

Being confronted again, in 1910, with a most unusual opportunity for pushing scientific investigations in Mexico for the sake of science and the economic well being of both countries, an effort was made to organize and finance an expedition with a larger scope than that of 1909. Through the interest of Prof. A. J. Cook, head of the department of Biology in the College, a sufficiently large sum of money was secured from friends of this work to send two men from here and to hire the services of a native helper. With the assistance of Mr. C. E. Harwood of Upland, Cal., his son, Mr. Paul Harwood, Dr. W. S. Cockrell and Dr. Pehr Olssen-Seffer, all of Mexico City, passes were secured over the National Railways first and later over the Vera Cruz and Isthmus Road, the Mexican Road and the National Tehauntepec. We here take the opportunity to thank the above mentioned gentlemen, and also the officials of the roads over which passes were granted to us: Mr. C. R. Hudson, Vice President of the National Railways; Mr. Thos. Milan, President of the Vera Cruz and Isthmus; Mr. Newberry, President of the National Tehuantepec; and the Manager of the Mexican Road.

Mr. A. S. Loveland, a student of the college, was chosen as my assistant. A very good native helper was hired at Guadalajara, Jalisco. In addition to these two assistants, guides in several places were used.

The purpose of the expedition, as outlined by Prof. C. F. Baker, was to make as extensive collections as possible of insects, economic seeds, both of fruits and ornamental plants and trees, mosses and lichens, living plants, especially palms, cacti, orchids, agaves and succulents of all sorts, etc. It was first thought best to confine our collecting to about four localities south of Mexico City, well separated topographically as well as geographically. These plans were subsequently altered to include about seventeen localities representing six states of Southern Mexico: Chiapas, Vera Cruz, Puebla, Oaxaca, Morelos and San Luis Potosi. The reason for this change of plans was the desirability of making this year's efforts something in the way of a thorough reconnaissance of the southern half of Mexico, as a preparation for future expeditions as well as for permanent work in the future. It is a great advantage to know the typical localities over a large area of territory and to know the country in a comparative way. For this reason the work was necessarily somewhat hasty in most places, but by continually keeping on the move the desired results were in a measure attained.

On June 16th we entered Mexico through El Paso and proceeded directly to Mexico City, where a few matters of business occupied our time for some days. After the completion of this business we went to Cuernavaca,

*Student assistant in Pomona College.

state of Morelos, for a few days of collecting. In spite of the frequent rains we found this region very productive. I was enabled here to see the work of the Mexican orange-maggot, the larva of *Trypeta ludens*. At this time the oranges had not begun to ripen, but the mangoes, which are also attacked by this same maggot, were at their best. I attempted in all the places visited during the summer to acquaint myself with the exact extent of the injuries and the measures taken toward its control or extermination. A detailed account of these observations with the measures used and other measures proposed has appeared in a report on the *Trypeta ludens* in Mexico, published in the Pomona Journal of Entomology.

The climate and topography of Cuernavaca make it quite subtropical in vegetation as well as in its faunal life, so that this spot has become quite famous to entomologists. To the agriculturist it ought to be much more valuable. With its fine soil, abundant rains, even climate and a tremendous market in Mexico City, only four hours distant by rail, the Cuernavaca Valley should be one of Mexico's garden spots.

From Cuernavaca to the City of Mexico the train passes over a high range of mountains, slightly more than ten thousand feet above sea level at the highest point reached. On our return to the city we stopped for one day at a small Indian village, called Parres, very near to the summit just mentioned. Some very interesting specimens were taken at this elevation, as might be expected.

Leaving Mexico City for the second time we set out for the state of Chiapas, on the Pacific side and at the extreme southern end of the Republic. Although it is not a very great distance from the Capital, yet the journey required over four days, owing to slow transit over rather new road beds. Our headquarters in this state were made at the Soconusco Rubber Plantation, Hacienda Dona Maria, near Escuintla. We were given many favors by the field manager of the plantation, Mr. Rolf Olssen-Seffer, which aided very much the work of the expedition. From this place a trip was made to Tapachula, only a few miles from the Central American border, and from this latter place another trip far up into the mountains where lies the great coffee district of the state. The type of insect fauna in this state is, of course, tropical, and except when hindered by the frequent tropical thunder showers, we were able to do some very good collecting. I had been requested by Dr. Pehr Olssen Seffer to make what studies I could on a certain boring beetle existing in the rubber trees, *Castilloa elastica*, and try to find some effective remedy. A report of these investigations has been published in the American Review of Tropical Agriculture. The well known coffee mildew was found very abundant in the coffee district in the mountains. Attempts have been made in various ways to control the moisture which favors the mildew, but they do not seem to be entirely successful. Resort may have to be taken, as was suggested to one of the planters, to cutting narrow lanes in the direction which the wind takes. This has been tried in other places with more or less success. Mention need not be made of the numerous minor

pests which occur in this state, such as the aphids, scale insects, thrips and leaf-eating beetles, etc.

Leaving Escuintla about the last of July we started back over the Pan American Railway for the Tehuantepec Isthmus territory where we spent a day collecting. This region is quite barren in comparison to the luxuriantly wooded southern part. From San Geronimo, state of Oaxaca, we went across the Isthmus to the state of Vera Cruz, stopping next at Medias Aguas. Here we found a very interesting country, distinctly tropical in its floral and faunal life and yet more mild in its climate than the state of Chiapas. We had an opportunity at this place to see the Castilloa rubber tree growing in a more northern latitude than in Chiapas, and in fact the difference could be readily seen in its slower growth. The insect fauna was very varied and the collecting good. Orchids and palms were quite numerous and varied. The rubber tree borer of Chiapas was not found here, although there were occasional decaying spots which usually are very attractive to such insects.

Santa Lucrecia, the junction of the Vera Cruz al Istmo and National Tehuantepec lines, was the next point visited, but for only one day. Although this is a proverbially hot locality, still the insects seem to thrive as well as at any other place. The topography here, however, was not enough different from Medias Aguas to warrant a longer stay.

Our next stop was in the city of Vera Cruz, from which we took several short side trips into the country districts within fifteen or twenty miles of the city. An hour's ride over the Vera Cruz and Isthmus line brought us to a very good locality for collecting both insects and palms. Some time was spent in collecting certain marine material near the large breakwater. With the intention of returning to this place again at a later date, we left by way of the Mexican railway for Cordoba. This we found to be a very beautiful and rich locality with a very delightful climate. The soil is equalled in fertility by only a few places in other parts of the Republic, but the production is by no means proportionately rich, the reason for which, no doubt, is the lack of advancement in the native farmer. However, some of the best mangoes in the Republic are to be had here, as well as pineapples and some other varieties of fruit.

From Cordoba we went directly to Orizaba, which is situated in a fair sized valley considerably higher than Cordoba. This also is a very rich locality, a little less rolling than Cordoba and with very deep alluvial soil in most places. Some very good collecting was done on the verdant and well-wooded hill and mountain-sides.

On our way to Puebla from Orizaba we stopped one day at a small village called Maltrata, situated in a high valley above Orizaba. A great difference was noted in the relative fertility of this place and the one last visited. This soil lacked humus and seemed to be very unproductive in most sections, although in a few places there were some flourishing groves of various sorts. Going on to Puebla still by way of the Mexican railway we continued to pass

through large or small valleys, some with water and some without, as was Maltrata.

Puebla has an elevation of about seven thousand feet and is well within the inland table-lands. No matter in which direction one may leave the city nothing is seen for miles and miles except vast cornfields. Since territory of this description contains very little of interest to the collector, we passed on down south, after a single day's stop, to the Oaxaca valley. To anyone except the student and collector of cacti and other desert plants the ride from Puebla to Oaxaca is very tiresome, owing to the many miles of intervening desert. One feels fully repaid, however, for the dreary ride when the Oaxaca valley comes into view. Several days were very profitably spent here in collecting in the neighboring mountains and meadows. A very pleasant trip was made to the state experimental station just outside the city of Oaxaca. Although the station is but one year old, yet the results are already forthcoming through its director, Mr. Felix Foex. On our return north we stopped a short time in the middle of the previously mentioned desert where a large number of cacti and agaves were collected, as well as a fair representation of desert insect life. From this point, Tomellin, we went directly to Vera Cruz, via the National Railways (Interoceanic). Here we spent a few more days profitably since the faunal and floral life had undergone further seasonal development during our absence of three weeks.

A few days at Jalapa completed our round-about itinerary from Mexico City and return.

Jalapa was another of the places classed as beautiful as well as rich, in our estimation. Situated well up in the mountains it has a very agreeable climate and is still tropical in aspect. For palms, orchids, ferns and similar plants we found no place equal to it; and for insect collecting also it proved very rich.

From Mexico City a second trip was taken into the state of Morelos chiefly for the purpose of seeing the orange maggot at work on the ripening orange crop. A short visit was paid to Cuernavaca, although there are very few oranges raised there. A longer stay was made at Yautepec, said to be the center of the Republic's citrus industry, and also the worst infested with the maggot.

Several days were spent in the City of Mexico on our return from Morelos visiting the National Museum at Tacubaya under the charge of Sr. Fernando Perez, and the central agricultural experiment station and National Agricultural College, both under the direction of Dr. Jose Ramirez. A trip was made to the Toluca valley west of the city, where a great deal of fruit is raised for the city markets.

The last place visited by the expedition was the region of San Luis Posoti. This is well within the limits of the great northern desert, where the chief vegetation is cactus and mesquite. Very little insect collecting could be done in the vicinity of the city, but a trip to the Rio Verde district proved a little more successful. Here we visited the state experiment station and were

very cordially shown about through the several departments of work. While very little stress is being laid on experimentation with trees adapted to the surrounding conditions, still some very good work is being started in experimental dry farming of corn and other crops.

Looking back over the whole season's work we may note that although a great deal of difficulty was met in operating during the rainy months and the work thus hindered, yet collections made at just this season often exhibit forms unknown to other seasons. Another expedition in the winter months following in general the same itinerary would undoubtedly give very interesting results in a comparative way.

All the specimens collected were forwarded immediately to Pomona College. There all the insects, amounting to above fifty thousand specimens, will be mounted and preserved. Most of the entire collections have been presented to the college museum, but some groups will be presented to other museums or offered for sale or exchange.

As is suggested by the fact that the entire Republic has but four agricultural experiment stations, agriculture has not yet reached the plane which it is hoped it soon will attain. There are three evident reasons for this. First, the Mexican as a rule is not naturally a farmer. Most of the land is divided into tracts known as haciendas and the owners of these tracts are nearly always Mexicans or Spaniards, who are called hacendados. Unfortunately the majority prefer greatly to allow their farms to be run by subordinates while they themselves spend almost their entire time in the city. As a result of this the hacendado cares very little how his place is run or what is done in the way of planting, and quite naturally will not give attention to any agricultural innovations. Second, the native Indians, who constitute largely the peon class and who do most of the actual farming which is done in the Republic, know absolutely nothing of agricultural methods except what they learned from their grandfathers and great-grandfathers. If one asks an Indian farmer why he does this or that he answers: "My father did it this way and his father taught him, so why should I not do it, also?" But in spite of this trait, if the Indian is *shown* something new and *shown* that it is better and more remunerative than what he has, he will, as a rule, give it a trial. And this brings us to the third reason, the lack of experimental stations and demonstration farms to actually show the native farmers what are the best crops for his soil and what are the best methods of raising those crops and tilling his soil. And this third reason is, after all, the most important because the hacendado will simply lose his property to some one who can farm it if he does not wish to, and the Indian can be educated to decent methods of agriculture if he will or else drop out, but agricultural conditions in Mexico will never improve to any appreciable extent if good, practical, and efficiently managed experimental stations and demonstration farms are not established soon in greater numbers than at present exist. Until this change for the better takes place the land will continue to produce less than it is capable of

producing, in fact suffer constant depletion and the entire country will feel this loss.

What might almost be called the universal crop of the country is corn; it is grown on large tracts of hundreds of acres and it is grown on small arable patches on the mountain sides; and yet not in any year has there been enough to feed the nation. The reason for this is not hard to find. I have seen thousands of cornfields "plowed" with the ancient wooden plow drawn by oxen and I have seen a few cornfields plowed deep with modern steel plows, and the difference is great. When a soil is scraped over the surface year after year and never turned, what sort of a yield of corn can be expected? And yet because of the great original fertility of some soils the yield is surprisingly good; but that condition is rare and will not last. The usual crop is much smaller than it need be.

Again, a great deal of land is annually planted to corn which would be far better suited to some other crop. Some of the higher mountain valleys and mesas are quite well adapted to corn culture, but many such places, while they may be forced to produce some inferior corn, are far better suited to the culture of such crops as the apple, cherry or some other hardy, cold enduring fruit. It may be difficult for many to believe that cold climates exist in Mexico, but nevertheless it is entirely true. On many of the mountain plateaus and mesas the temperature falls low enough for snow and very hard freezing. Portions of the Tehuantepec Isthmus territory, also, because the soil conditions are not adapted to its culture. There is very little doubt in my mind as to the adaptability to this soil of the olive tree or the eucalyptus and many other similar trees. The market price of olives is so high that this crop could be made to pay very well. In this very region as well as in other parts of the Republic there is a great demand for good railroad ties and telegraph poles, and this demand will increase constantly. Eucalyptus wood is beginning to be used in this country for such purposes with good results, and a similar demand in Mexico should stimulate its culture on a very large scale in certain states.

While we must realize that the habits of the masses of the Mexican people demand corn as the chief crop of the country, at the same time one cannot help recognize certain places as being well fitted for other crops equally valuable to the country. For instance the Cuernavaca valley with its wonderfully fertile soil, mild climate and abundant rains in season could produce, after proper acclimatization, grapes, melons, berries and other similar crops which have to be marketed immediately. Mexico City, only four or five hours distant by rail, affords a limitless market for such fruits, and the consequent lowering of the present market price of these products would place them within the reach of many more. The current retail price of table grapes in the city is about twenty-five cents per pound, and other fruits are proportionately high. The sugar beet could be grown very well in several localities of large extent as, for instance, in the Yautepec region of the state of Morelos and in the southern part of the state of Vera Cruz. Whether this could be

made to compete favorably with the sugar-cane would be a matter of some doubt until a trial had been made, but they make splendid food for hogs and cattle. The San Luis Potosi territory is admirably adapted to the culture of the maguey fibre, as are, also, other parts of the country.

One must bear well in mind that most of the crops mentioned here have to be acclimatised before they can produce, and this work rightly belongs to the experimental station. There are many methods of grafting and crossing and selecting known to the expert horticulturist which are wholly unknown to the average farmer. Therefore it is only reasonable that the government should take this into hand and develop it for the good of the country as a whole, just as it is done in many other countries.

Then again there is the improvement of crops and methods of culture now existing in the country in a more or less undeveloped state. Under this would be included the breeding and introduction of better varieties in all parts of the country. The peaches are always small and often of very inferior taste simply because there has been no attempt to better them; then, too, the trees do not receive proper care. The same is true of the orange. Often the trees are scattered indiscriminately among other trees and receive no cultivation or care. In some cases, as at Yautepec, in Morelos, the trees are set out in much the same way as they are here, but no attempt is made to improve the varieties by grafting or budding, and, furthermore, many of the trees are eighty to one hundred years old. The oranges are usually quite sweet, but they could not compete with improved stock for several reasons; they are somewhat inferior in taste and quite inferior in appearance. As a proof of this, the seedling oranges are sold on the street for from one to five cents each (Mexican money), while the navel oranges (some are grown in Jalisco, Sonora and other states) are sold for from four to ten cents each, and are considered much more of a luxury.

This work of improvement also belongs to the experimental farm, and should be developed along with the initiative work mentioned above. But for this work as briefly outlined, four stations, three field stations and one central and purely technical, are far from adequate. It is no doubt the present intention of the Mexican government to establish more stations in the near future, and it is sincerely hoped that they will come soon and be made very efficient for the needs demanded of each. Great things are in store for the agriculture of Mexico, if it is energetically developed. It will be a source of immense national wealth when the mines have all been exhausted.

The Botanic Garden of Para

BY C. F. BAKER

Every botanist and horticulturist is familiar with accounts of the magnificent forests, the wonderful display of palms, and the luxuriance of plant life in general, to be found in the Amazon Valley. Few, however, are acquainted with the Botanic Garden of Pará, near the mouth of the Amazon, long ago founded by Dr. Goeldi and now under the control of the Museu Goeldi, with Dr. Jacques Huber, a most devoted and learned botanist, as Director. Through

Figure 22. A view in the southern extension of the garden.

the liberal support of the government of the State of Pará, this Botanic Garden has been able to draw upon practically the whole Amazon Valley for its material and so possesses collections of unique interest and value. The field operations of the Garden have extended from French Guiana and the mouth of the Amazon, to the eastern slopes of the Andes, where Drs. Goeldi and Huber collected in the rich valleys of the Ucayali and the Huallaga. In intervening territory Dr. Ducke has traversed the Rio Negro, the Rio Trombetas and

Figure 23. Showing the fine development out-of-doors of plants only known in northern greenhouses. Note the large Monstera on the tree and the fine marant in center of bed.

many other streams, and Andre Goeldi brought back quantities of living material from the Rio Purus and elsewhere. The writer had the keen pleasure of serving as Curator of this Garden and its great Herbarium for nearly a year, and will briefly indicate here some of the points of interest connected with it.

On entering the Botanic Garden at Pará, one is impressed by the density of the plantings which lack of space has compelled, but which has, however, produced a most characteristic Amazonian effect. One first recognizes numbers of the standard tropical ornamentals, *Murraya, Hibiscus, Tabernaemontana, Datura,* various *Ixoras,* and some more conspicuous things, such as *Randia Stanleyana* with its long trumpet shaped whitish flowers, *Roupellia grata,* and *Brunfelsia grandiflora.* Scattered among these are great numbers of fine native Amazonian ornamentals, many of which have not yet been introduced to horticulture, but which would add great riches to our warm-house collections. A notable example of this is a fine series of *Marantaceae,* including several *Thalias,* numbers of *Ischnosiphons,* and many new *Calatheas* recently described by Dr. Huber, for example, *C. contaminensis, C. lactevirens, C. aberrans, C. Sophiae, C. Ucayalina,* and *C. microcephala*—every one a gem. Equally noticeable is the great wealth of aroids—*Monsteras, Anthuriums,*

Figure 24. A forest scene in the gardens. Note the huge Calathea at right.

Philodendrons, and *Dieffenbachias*, numbers of them still undescribed and never in horticulture, and most noticeable of all that strange, gigantic, almost tree-like aquatic *Montrichardia arborescens*.

Throughout the Garden, everywhere, there are conspicuous epiphytic orchids, bromeliads, and *Piperaceae*, and also parasitic *Loranthaceae*—some so abundant as to necessitate frequent cutting away. The Garden has now the beginning of a really notable collection of Amazonian orchids. In one part of the Garden several remarkably fine *Carludovicas* are much in evidence, and there are also fine specimens of the Guiana Traveller's Tree (*Ravenala guian-*

Figure 25. An Aralia hedge with Achras sapota in background. The bust is of Ferreira Penna, a famous Brazilian geographer.

ensis). After having been familiar only with the old *Heliconia Bihai* of the more northern tropics, it was a great pleasure to see here a fine collection of *Heliconias*, some newly described by Dr. Huber and apparently none of them in horticulture; in this collection were *H. pendula* Wawra, *H. stricta* Huber, *H. cannoidea* Rich., *H. episcopalis* Vell. Besides the old-time *Bambusa vulgaris*, the Garden possesses a number of native Amazonian bamboos, most of them unknown to horticulture, and one of the finest only recently described by Dr. Huber under the name of *Guadua superba*. In some borders of the Garden, occurring almost as weeds, are to be found two large, fine *Solanums* which ought to be cultivated if they are not—*S. juripeba*, and *S. grandiflora*.

All of the fruits so characteristic of the more northern tropics, such as papaya, anon, aguacate, mango, mamey, caimito, sapodilla, sapote, and others, are represented in the Garden, and besides these a most interesting series of more strictly Amazonian fruits, some almost unknown outside of that region, such as:

Mangabeira - - - - - - - - *Hancornia speciosa* Gom.
Amapá - - - - - - - - - - - *Hancornia amapa* Huber
Uchi - - - - - - - - - - - - *Saccoglottis Uchi* Huber

Figure 26. One of the finest views in the gardens. The ornamental water tank is draped with Antigonon leptopus.

Umary - - - - - - - - - - - *Poraqueiba sericea* Tul.
Castanheiro (Brazilnut) - *Bertholletia excelsa* HBK.
Piquiá - - - - - - - - - - - *Caryocar villosum* Pers.
Ingá cipó - - - - - - - - - *Inga edulis* Mart.
Pajura - - - - - - - - - - - *Parinarium montanum* Aubl.
Parinary - - - - - - - - - *Couepia chrysocalyx* Bth.
Sorveira - - - - - - - - - *Couma guyanensis* Aubl.
Oity - - - - - - - - - - - *Moquilea tomentosa* Bth.
Abiu - - - - - - - - - - - - *Lucuma caimito* R. S.
Cutitiribá - - - - - - - - - *Lucuma rivicoa* Gaertn.
Baury - - - - - - - - - - - *Platonia insignis* Mart.
Bacury-pary - - - - - - - - *Rheedia macrophylla* Planch. and Triana.
Biribá - - - - - - - - - - - *Rollinia orthopetala* A.D.C.

The two *Hancornias* also produce a sort of rubber, but their fruits are the most uniquely flavored and deliciously fragrant of perhaps any of the Amazonian fruits. The Abiu and Biribá—at their best—are the peers of any tropical fruits. It should be noted that there are hundreds of seedling varieties of all of these fruits in the Amazon country, and among them in each case, are represented everything from good to bad.

Figure 27. Guadua at left; at right a large bed of Calatheas of many species.

There are also represented in the Garden a series of the cherry-like myrtaceous fruits, all worthy of cultivation, and with great possibilities if modern methods of cultivation and breeding were applied to them. Among these are:

Jaboticába - - - - - - - - *Myrciaria cauliflora* Berg.
Pitanga - - - - - - - - - - *Stenocalyx michelii* Berg.
Grumixama - - - - - - - *Stenocalyx brasiliensis* Berg.
Aracá do Pará - - - - - - *Britoa acida* Berg.

In fact, horticulture has yet to see some of its greatest marvels when modern methods of cultivation and breeding are applied to the tropical fruits.

There is but limited space in the Garden for specimens of the great timber and forest trees of the Amazon, and yet Dr. Huber has gradually built up a considerable collection of living specimens, some of them already of good size. Conspicuous among these is the fine assortment of leguminous trees belonging to such genera as *Inga, Pithecolobium, Caesalpinia, Macrolobium, Campsiandra, Swartzia, Hymenaea, Sclerolobium, Crudya* and *Lonchocarpus*. Besides the larger trees, there are everywhere scattered through the Garden a great collection of small trees, all of them of great botanical and horticultural inter-

Figure 28. A propagating house built by the author almost entirely from waste materials found on the place. Trees in background are Lucuma Caimito at left and Persea gratissima at right.

est, and among which may be noted in passing several *Cecropias, Qualea speciosa* Huber, *Voucapoua americana* Aubl., *Vatairea guyanensis* Aubl., *Crataeva benthami* Eichl., *Virola surinamensis* Warb., *Pachira aquatica* Aubl., *Quararibea guyanensis* Aubl., *Matisia paraensis* Huber, and *Dillenia speciosa*. Some of these also eventually attain good size. *Pachira* produces the well-known enormous pompon-like flowers and is a conspicuous feature along the Amazon.

Situated in a country long known for its palms the Garden should be expected to possess a fine collection of these regal plants, and it certainly contains a magnificent display of them, and is constantly making additions to its collection. Conspicuous among the palms is the graceful and beautiful Assahy (*Euterpe oleracea* Mart.), and the huge Pupunhas (*Guilielma speciosa* Mart., and *G. microcarpa* Huber). Other fine palms are the

Mirity - - - - - - - - - - - *Mauritia flexuosa* Mart.
Yauary - - - - - - - - - - *Astrocaryum jauary* Mart.
Murumurú - - - - - - - - *Astrocaryum murumuru* Mart
Tucumá - - - - - - - - - *Astrocaryum tucuma* Mart.
Patauá - - - - - - - - - - *Oenocarpus batava* Mart.
Bacaba-y - - - - - - - - - *Oenocarpus multicaulis* Spruce.

There are also represented many others in the genera *Maximiliana, Geonoma, Chamaedorea, Iriartea, Phytelephas, Bactris, Cocos, Attalea,* and *Manicaria*.

In two groups of plants in which Dr. Huber is a noted specialist, viz., the genus *Theobroma*, and the Amazonian rubber producing plants, the Garden possesses the finest collections in the World. Among the many very interesting *Theobromas* represented are several varieties of *Theobroma cacao* L. (the Cacao of commerce), *T. bicolor* Humb. & Bonpl. (Cacao do Peru), *T. grandiflorum* Schum. (*Cupuacu*), *T. subincanum* Mart. (*Cupuahy*), and *T. speciosum* Willd. (*Cacao*-y). Dr. Huber calls the Cupuacu the King of Tropical Fruits, and it is certainly altogether aristocratic among fruits. With the *Theobroma* collection may also be seen the very peculiar related *Herrania paraensis* Huber, rarely represented in collections, even by herbarium specimens. The rubber producing plants of the Amazon fall into six genera: *Landolphia*, represented by a new Amazonian species—*paraensis*, just discovered by Dr. Huber; *Hevea*, the genuine Pará Rubber, called Seringueira; *Castilloa*, called Caucho; *Sapium*, called Tapulu, Murupita, Curupita, or Seringarana; *Mimusops*, called Macaranduba and Maparajuba; and *Hancornia*, called Mangabeira. In *Hevea* and *Sapium*, Dr. Huber has discovered many new species, and most of these are growing in the Garden, as is also the new *Landolphia*. Besides many of the older species, one may note in the Garden fine specimens of the following of Dr. Huber's new species: *Hevea collina, H. cuneata, H. viridis, H. Randiana, Sapium Marmieri, Mimusops amazonica, M. maparajuba, M. paraensis*.

The instant thought to an American botanist or horticulturist visiting this great Garden is this: Why, with such a marvelous flora so near us (not

more expensive a trip than to California, from New York) have we not drawn on it more freely and widely? Besides all of the interesting, beautiful, and valuable things in orchids, bromeliads, marants, aroids, palms, and other plants which I have mentioned as growing now in the Pará Garden, there are also in the Amazonian forests wonderful displays of *Melastomaceae, Bignoniaceae, Passifloraceae,* and other beautiful and interesting things, awaiting the collector. Something of the extent of the Amazonian flora may be appreciated from the fact that above 1200 species of forest trees are already known from the banks of the lower Amazon, and Dr. Huber tells me that even there great numbers of the existing species of trees are still unknown to Science.

It is not many years ago that a trip to the Amazon seemed a very great undertaking but now New York steamers not only reach Pará frequently, but pass into the Amazon itself and twelve hundred miles up that river to the city of Manaos, and sometimes the same steamers go on eleven hundred miles farther to Iquitos in Peru, only five hundred miles from the Pacific Coast.

Let us hope that our botanists and horticulturists will awake to the great opportunities existing in that Paradise of Plants, and hasten to send down trained men who can bring to us freely of the riches of that wonderful country.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume I MAY 1911 Number 2

Die-Back or Exanthema of Citrus Trees

(A Physiological Disease)

BY E. O. ESSIG
HORTICULTURAL COMMISSIONER OF VENTURA COUNTY, CALIFORNIA

INTRODUCTION

Citrus Die-back was first described in Florida in the year 1875 by F. H. Fowler*, but when it actually appeared in the orchards has never been ascertained. In California the disease was known in San Diego county in the year 1890 on trees which had been imported from Florida. From its first appearance to the present time there has been much confusion in the minds of citrus orchardists regarding the appearance, work and control of this disease. Since the publication of Bulletin No. 8 by W. T. Swingle and H. J. Webber of the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, in 1896, a better understanding of the die-back disease has become general, and since then many helpful and valuable suggestions have come from B. F. Floyd, H. H. Hume and H. S. Fawcett of the Florida State Agricultural Experiment Station. In California the investigations have not been as extensive as in Florida, because the disease is not as severe here, but several articles have been published regarding it. The first appears in the report of the California State Board of Horticulture in the year 1896, and again in 1902. J. W. Miller, in Bull. No. 132 of the Cal. Exp. Station makes a strong statement regarding its destructiveness in the San Gabriel valley. Ralph E. Smith refers to the disease in a speech before the State Fruit Growers' convention at Marysville in 1907, and since that time reprints of the progress in Florida have appeared in the California Cultivator from time to time. So far there has never been any means of bringing together all of the known knowledge concerning die-back in a connected form for the use of the citrus growers of this state, which accounts in a large way for the present confusion. It is not an uncommon thing to hear growers speaking of wither-tip and die-back as being one and the same thing, and ofttimes I have had this as a query from local growers. In the last number of this Journal the wither-tip was fully discussed and illustrated, so as to make its identity beyond a doubt. In this article I wish to make clear the physiological disease, die-back, by presenting all available knowledge acquired in Florida and in this state, together with illustrations taken in our own orchards. I shall quote freely from all publications listed under the heading "Literature" further on.

*Bull. No. 8, Div. Veg. Phys. & Path., U. S. Dept. Agricl., pp. 14, Note.

Nature of Die-Back

So far as present knowledge goes, die-back is not a fungus disease at all. There have never been found mycelial threads or fruiting bodies which are characteristic of the true parasitic fungi as well as of other members of this group. It is considered, then, a physiological disease similar to Gummosis, Mottled-leaf, Barrenness, etc., the nature of which are not often clearly understood.

History and Distribution

As was already stated the die-back disease was first described in Florida as early as 1875, and is believed to have originated in that state. For some years it was not known to exist in any other locality. Later it was found to have spread very rapidly in that state until in 1907 Hume states that it could be found in practically every citrus orchard in Florida.

It was introduced into California on nursery stock along with other disastrous Florida diseases and first came under observation in San Diego county, being reported by F. Austin, then secretary of the County Board of Horticultural Commissioners, in 1896, although it was stated that the disease had been observed on the same trees for six years, making its introduction approximately 1890. Since that time it has been reported in the San Gabriel valley, along the foothills from Highlands to Pasadena, and is now located in three orchards in Ventura county.

Die-back was reported as existing in the citrus orchards of the Hawaiian Islands in 1905, and in Arizona in 1908, so today it is present in practically every citrus section in the United States, but has never been reported from South America, Australia or from other citrus sections in the Far East.

Appearance and Symptoms

Trees affected with die-back usually present a very dark-green color, although this is not always a sure case of die-back. In severe cases the tree remains dwarfed, with a narrow, oblong shape, and may eventually die. Then, too, the top may be very small, but composed of very compact foliage, due to an excessive production of tender shoots. The dying back of the ends of the twigs and the formation of numerous new shoots often give the trees a very regular and trimmed appearance, but in advanced stages they appear very irregular and ragged.

Twigs

(Figure 29, A and C)

Young—The young twigs on a badly affected tree first begin to turn yellowish before the leaves are matured. The leaves may fall or not. Swellings or gum pockets begin to appear, gum exudes, covering portions of the twigs and leaves with a reddish-brown coat.

Drooping—The ends of the twigs usually droop slightly at first. Later the tip may curve upward, giving the end of the twig an s shaped appearance. The end dies back from four to six inches (Fig. 29 C).

Gum Pockets—(Fig. 29 A). The swelling appearing upon the young stems between the leaves on the internodes or at the bases of the leaves at the nodes, are caused by the formation of gum pockets within the stem. A cross-section of these

show them to be filled with a clear gum-like substance. The pockets resemble water blisters and are more or less oblong in shape and vary from one-quarter to one-half an inch in length.

Multiple Buds—(Fig. 29 C). Is the name used by Mr. Floyd for the abnormal number of buds which arise from a single axil. There may be from two to four thus formed, where in a normal case only one bud would be found. These buds are sometimes accompanied by an exudation of gum which may in time completely cover them with a reddish-brown stain.

Figure 29. Die-back on Orange: A, showing gum pockets; B, cross-section of a Valencia, showing gum at core; C, twig showing multiple buds and dead tips.

Bark Eruptions—In more advanced stages the gum pockets erupt and allow the gum to flow out in numerous places over the stems. Eruptions also occur from the leaves, showing that the gum does not always come from well defined gum pockets. The gum that oozes out forms small patches, regular or irregular, of resin-like substance, which becomes reddish-brown and which is so characteristic of this disease. This gum soon hardens and presents its natural appearance for a long time. Excellent dry specimens of this stage may be preserved in the laboratory indefinitely.

Die-Back—(Fig. 29 C). The young twigs die back in a very marked manner as described above, and as is well shown in the accompanying illustrations. The dead portion may remain light in color, but is more often covered with a black saprophytic fungus growth. The length of the dead portion varies with the size of the limb, but usually continues from the tip back to the first well defined branch.

Old—The old twigs present much the same symptoms as do the young. The bark erupts and the characteristic reddish-brown stain pads are formed. The affection takes place only in the bark, which is sufficient to kill back old branches almost to the trunk of the tree. In this state I have been unable to find such a case, but it has been reported as occuring in the San Gabriel valley before the year 1902. In Ventura county we find only the young and tender growth killed back.

Leaves

The leaves first turn yellow, as described above, and may or may not fall. Those that do not fall soon begin to show an exudation of gum and the formation of regular or irregular reddish-brown pads over both surfaces, but usually beginning near the mid-ribs and spreading outwardly. Swingle and Webber attribute much of the staining of the leaves as due to the punctures made by scale insects and red spiders, claiming that in many instances the infection takes place only where the tissues were injured.* It is also claimed that the leaves are usually larger and longer than on a normal tree. This has been observed here, but we attributed it to the formation of the so-called water-sprouts caused by the die-back disease which always produce very large leaves.

On a tree that is just beginning to show symptoms of having die-back the leaves appear a deep green color, which is characteristic of an orchard well fed. Of course such a color cannot be taken as an indication of this disease, since all healthy groves show a deep green foliage.

Fruit

(Figures 29 B and 30)

Discoloration—When the fruit is about the size of an average walnut it begins to assume a lighter color and may even turn to a lemon yellow. At this stage it begins to fall and may continue to do so until the last stages of the disease, when there is very little left upon the tree. Soon the brown staining begins and may cover the surface in patches of minute reddish-brown speckles or in an unbroken irregular blotch, which nearly covers the entire surface.

Splitting—(Fig. 30). Accompanying the staining of the fruit is the splitting. The splits or cracks first appear as small "chaps," which gradually lengthen and widen until the core of the fruit may be exposed to view. This splitting may occur even before the staining, but usually as stated above. The crack may begin on the side of the fruit or at the blossom end. It is certainly disastrous to the market value of the fruit, as the appearance is very repellent. The trees affected in this county show great quantities of this insipid and split fruit, much of which is already on the ground. The fruit so cracked is called "*ammoniated*" fruit by Floyd.

Gum-Pockets—Fruits which show splitting or which do not show splitting or even staining, sometimes show the formation of small gum-pockets in the rind or peel, just under the surface. This is found quite abundant on affected sour orange trees.

Again, there may be a formation of gum near the center of the fruit about the seeds and core (Fig. 29 B). The dark area in the figure shows this. The gum so

*Bull. No. 8, Div. Veg. Phys. & Path., U. S. Dept. Agrcl., p. 17.

deposited may be colorless or slightly brown. This condition is quite prevalent in the Valencias on affected trees at Santa Paula, and cannot be told by any outward appearance of the fruit.

Dropping—The fruit first begins to fall before any staining may be noticed, shortly after the first discoloration. It may continue to fall slightly until the first signs of splitting, when most of the fruit drops to the ground. At the time of maturity there is not enough left on the tree worth picking, and what is left is usually thick-skinned and unfit for market. On the Valencia trees referred to above, and which are seven years old, there are not more than two boxes of fruit on twelve trees to date (March 26, 1911,) while neighboring trees are very heavily loaded. Neither is there much upon the ground, for the trees have never borne a good crop since they were planted.

Figure 30. Die-back on Orange: A, Valencia, showing typical reddish-brown stains and cracks in peel.

Causes and Conditions Favorable to Growth

The exact causes of die-back are not all thoroughly understood, but enough is known of the disease to tell almost with exactness the conditions which are favorable to its growth and which will nearly always produce its characteristic symptoms. It is the general belief that the disease is caused by malnutrition, that is, an irregular or improper food supply.

The conditions most favoring its growth are excess of ammonia and improper soil conditions.

Excess of Ammonia—In Florida this seems to be the chief source of trouble, and much more time has been given to the investigation along this line than along any other. Field experiments have been carried on for years with organic nitrogenous fertilizers and enough field observations made to satisfy experts that this excess of ammonia is a most favorable condition for the growth of die-back.

The excess of ammonia is brought about by using large amounts of stable manure, bone and blood, dried blood, cottonseed meal, and any excess of organic matter. In fields that have been highly fertilized for raising truck crops and later transformed into citrus orchards the die-back has been found to do great damage and to occur in almost every instance. This same is true of intensive farming between the rows of citrus trees and the application of organic fertilizers.

Trees growing in or near barnyards, stables, or chicken yards, almost invariably show die-back.

All of these observations, then, indicate that in Florida this really has been a great source of trouble, but in California the trouble is not so much of this nature. In almost every instance die-back here is caused by improper soil conditions.

Improper Soil Conditions—As stated above, are the usual cause of the die-back in this state, and should be the chief problem to be worked out with reference to this disease here.

Poorly Drained Soil—Or low soil is accountable for numerous cases of the disease in question. A large supply of water, bringing with it an over-supply of food, invariably produces the malady. The rise of bottom water during the winter months or during irrigation periods also produces a favorable condition for the spread of the disease. It is this last named condition that is responsible for the worst case near Santa Paula. The affected portion of the orchard is situated near the foot of a hillside where the winter water oozes down during the rainy season, and where the irrigating waters are stored up during the summer months. The soil is a stiff adobe with a few small rocks mixed in for about four feet, where an impervious clay begins. This heavy soil is able to retain a large supply of water and therefore affords a most unfavorable condition for the roots to thrive in. Poor cultivation and very irregular irrigations on the part of the owner add to the already unfavorable natural conditions, and as a result die-back has been able to get a thorough hold in the grove.

Hardpan and Underlaid Impervious Clay—Soil underlaid with hardpan or an impervious clay affords the condition for the worst case of die back. Such soils should never have been planted to citrus trees is the claim of many experts. In Florida the seat of most of the "soil die-back" is on such soils and large amounts of money are being annually expended to partially remedy this condition.

Granitic Porous Soils[5] This particular type of soil has been connected with die-back by Prof. Ralph E. Smith of the Whittier Pathological Station. At the Thirty-fourth Annual State Fruit Growers' convention at Marysville, in April, 1908, he makes this report: "This disease (die-back) is described in Florida as being due to an excess of organic nitrogen in the soil. That this is not entirely the case,

but rather that its cause is more complicated than this, is shown by the appearance of the trouble in this state, where it is limited almost entirely to a certain type of soil. This is the coarse granitic, very porous soil, which is found particularly along the base of the mountains in various places between Highlands and Pasadena. On such soils the Florida die-back is of quite frequent occurence. There have been a very few cases of this disease on heavier soils where the Florida experience seems to hold true, all the instances of such soils of which we are aware having been associated with very heavy applications of fertilizers rich in organic nitrogen. In the case of the type of soil mentioned, however, the disease occurs very severely in many instances where only moderate amounts of fertilizers have been applied. The most pronounced quality of this soil is the free passage which it affords to water. It becomes very wet during irrigations, but unless water is applied very thoroughly and carefully and quite frequently, the upper soil becomes absolutely dry between irrigations. This soil also takes up water very poorly in a lateral direction, so that the space between the trees and much of the whole body of the soil becomes extremely dry in many orchards. This disease appears to be brought about in some manner through an irregular food supply, resulting from irregular water supply which trees get in this soil, unless irrigation is particularly well carried out. With trees that are not well fertilized, the effect is simply one of ordinary die-back. True, exanthema seems to result where the soil is of the type described, and a fair amount of fertilizing material had been applied. It is apparently a sort of indigestion in the tree, more food being taken up during irrigation than the tree can take care of after it gets into the condition of dryness which follows. On heavier soils the same thing occurs only where very excessive amounts of nitrogen have been applied."

Improper Cultivation and Irrigation—Anything that tends to bring about malnutrition or indigestion in the tree may be a favorable condition for the growth of die-back. Proper methods of cultivation to aerate the soil and to conserve a regular water supply is important in controlling die-back. Irregular irrigations, with too much or not enough water at a time, may also bring about this disease.

Destructiveness

In Florida the die-back is more generally spread than any other citrus disease. It is claimed to be in every locality and doing damage wherever it exists. All writers make much of the amount of damage which is annually done. Swingle and Webber estimate an annual loss of $100,000 up to the year 1896. Hume and later writers make no estimate in dollars, but all state that the loss is very great. The actual loss is not always as easily determined as in the case of more positive diseases, but must be studied from a great many angles. Thus there must be considered the loss through the unproductiveness and slow development of the affected trees as compared with normal healthy ones; the excessive dropping of fruit; the coarseness and disfigurement of the fruit that does finally mature. Then there is the case where groves have been planted on improper soils which have produced a mild form of die-back, which is just sufficient to stunt the trees and cut down the yield with no real manifestations or symptoms of the real trouble. Much capital has been spent to bring such groves into proper condition without the owner

having the least idea of the cause of the trouble and the result being that little good was accomplished.

In California there have been no recorded facts with relation to the loss because of this malady. As has been stated, it was claimed that whole groves were destroyed before 1902 in the San Gabriel valley, and from time to time since then reports have come in that the disease has done considerable damage. In the reports of the State Pathologist for 1906 and from 1906-1909, the disease is mentioned as being more or less common, but no serious loss is recorded. In Ventura county, where the writer has made his observations, the greatest amount of damage may be accorded to a single orchard, where some twelve or fourteen trees are doing absolutely nothing for the owner. Many other trees also show signs of the disease, but not to any great extent. No doubt the greatest amount of damage in this state is in the production of stunted trees or "drones," which are doing absolutely nothing and which are a source of anxiety to the owner who does not know their ailments. Nothing could persuade the owner in Santa Paula that his trees were affected with die-back, and he could not be induced, by any means, to attempt any remedies. It is to be hoped that enough information can be given the growers in this article to enable them to diagnose the cases and to attempt a cure.

Control Methods

For Excess of Ammonia—Since an over-production of ammonia seems to cause die-back it is necessary to employ some means of preventing the tree getting too much in its food. This may be accomplished by cutting down the water supply and by cultivating only enough to keep the tree in shape through dry spells.

In plowing, all green manure crops or grass should be first removed from the grove to prevent the addition of more nitrogen. If any fertilizing is necessary, use sulphate of ammonia or nitrate of soda to obtain nitrogen. What has been said applies to an orchard which has had an excessive application of organic nitrogen fertilizers. When the condition has been remedied small amounts of organic fertilizers may be again applied, but with such fertilizers as stable manure, blood and bone, dried blood, guano, cottonseed meal, and green manure crops, add also potash and phosphoric acid.

For Improper Soil Conditions—Drain low and poorly-drained soils so as to prevent the over-accumulation of seepage water.

Blast out the hardpan under the trees if it is possible. This method has been very successful on soil of this type in Florida. Subsoilers may be used.

Irrigate regularly so as to prevent over-irrigation at some periods and a scanty supply at others.

Cultivate so as to aerate the soil in case of heavy soils, and try to keep the orchard in good condition. If this will not cure die-back it may be a good investment as a preventative.

Fertilize so as to avoid an excess of ammonia as described above.

Pruning in Relation to Die back—According to H. H. Hume, die-back in Florida often follows the freezing back of the tops, while the roots remain uninjured. The result is that the amount of food supplied by the roots cannot be utilized by the

smaller top and indigestion or malnutrition begins which in turn produces die-back. In such cases Mr. Hume recommends root-pruning. He says: "The amount of pruning required will depend upon the severity of the attack, the size of the tree and the character of the soil. Pruning may be done by cutting a circle around the tree with a sharp spade, thrusting it well into the soil so as to sever a large number of roots. The balance of the tree is restored by this method, and a complete recovery frequently follows this practice. It should be borne in mind, however, that in addition to this treatment, the cause of the disorder in the tree should be sought for and the conditions favoring the development of the die-back removed as far as possible."

Spraying For Die-Back—So far as I have been able to discover no work of this sort has ever been published as referring to such method of control in this state. Again, we must go to Florida, where it is claimed that very good results have been obtained by the use of Bordeaux Mixture. It must be remembered, however, that an underlying hardpan cannot be remedied by the application of sprays. In such cases, and in all cases, in fact, the cause of the malady must first be sought and remedied as far as possible. It is then that good results may be expected from the application of sprays. The Bordeaux Mixture is attributed by Hume as accelerating the assimilative processes in the leaves and other green parts of the tree due to the "chemo-toxic" effects of the solution, and not as a fungicide in the ordinary sense.

The mixture used for this spray is as follows:

Copper Sulphate (Bluestone)	6 pounds
Unslacked Lime	4 pounds
Water	50 gallons

Since a 4-4-50 Bordeaux Mixture has been found effective in spraying for the wither-tip disease, it might be possible to get good results with this spray on die-back at the same application.

Relation of Die-back to Wither-tip—While these diseases are widely separate in characters and methods of attack, yet they are often associated together on the same trees. The die-back, by weakening the tree, affords an excellent starting place for the wither-tip. Thus a slight attack of die-back may be followed by a severe attack of wither-tip without the presence of the die-back being manifested. This very thing happened in a Valencia orchard near Santa Paula this winter, and it was only after the wither-tip had abated that the die-back showed up.

The stained fruit of the die-back presents the same reddish-brown color of the so-called "red spot" of the wither-tip and where there are no splits, may be confused with it, unless careful observations are made. In the case of the die-back the red spots are never depressed, while in the case of wither-tip they are depressed and in more advanced stages present dark-colored fruiting bodies, while in the advanced stages of the die-back the red spots appear as pads and are accompanied by splitting of the rind.

Literature on Die-Back

(Bibliography)

1875. Fowler, Proc. Fla. Fr. Gr. Assn., Jan.
1876. Fowler, Fla., Its Sc., Cl., Hist., Appx. pp. 281-290. (Reprint.)
1893. Galloway, Rept. of Sec. Agrcl. U. S. Dept. Agrcl., pp. 268, 269.
1896. Swingle and Webber, Bull. No. 8, Div. Veg. Phys. Path., Dept. Agrcl., pp. 14-20.
1896. Cal. St. Bd. of Horti. In Rept. for Yrs. 1895-6, pp. 51-52.
1902. Cal. St. Bd. of Horti. Cul. of Cit. in Calif., pp. 132-133.
1902. Miller, Bull. No. 138, Univ. of Calif.
1905. Higgins, Bull, No. 9, Haw. Agrcl. Exp. Sta., p. 24.
1907. Smith, Bull. No. 184, Ca. Agrcl. Exp. Sta., pp. 251-252.
1907. Hume, Cit. Frs., and Th. Cul., pp. 283, 287, 308, 344, 377, 486-490.
1908. Smith, Proc. 34th. Fr. Gr. Conv., pp. 84-86, April.
1908. Floyd, Press. Bull, No. 90, Fla. Agrcl. Exp. Sta., May 2.
1908. Floyd, Press. Bull. No. 93, Fla. Agrcl. Exp. Sta., May 28.
1908. Coit, Bull. No. 58, Ariz. Agrcl. Exp. Sta., p. 325, Dec. 21.
1909. Smith, Bull. No. 203, Cal. Agrcl. Exp. Sta., p. 58, Nov.
1910. Wickson, Cal. Frs. and How to Grow Them, pp. 583-584, Mar.
1910. Fawcett, Cal. Cul., Vol. 34, No. 25, p. 725, June.
1910. Floyd, Cal. Cul., Vol. 35, No. 21, p. 500, Nov.

The White Sapote

BY F. W. POPENOE, PASADENA, CALIFORNIA

Among the fruits brought to California by the Franciscan fathers when they established their missions along this coast more than one hundred years ago were some, like the olive and the grape, whose cultivation is today an important factor in our horticulture. But there is one at least, which although introduced early in the nineteenth century, is at present cultivated only a little more extensively than it was at that remote day. This is the White Sapote, or Zapote Blanco of the Mexicans, botanically known as *Casimiroa edulis*. In the city of Santa Barbara there is still to be seen (Fig. 31) an aged tree which has survived all vicissitudes from the early mission planting, being without doubt over one hundred years old. This tree is one of the most interesting horticultural landmarks of California, as it has the honor of having been the first tropical fruit tree planted in this state. Several other trees much more recently planted are now in bearing and have helped to demonstrate that this fruit is well adapted to our climate, and with the increasing interest now being taken in the subtropical fruits it seems likely that this one will soon receive the attention which it deserves.

The White Sapote is a member of the order *Rutaceae*, and is found growing both wild and cultivated in the states of Sinaloa and Durango, and other parts of northern and central Mexico. The tree is handsome, having large, palmate leaves, glossy green on the upper surface, and with age forms a dense, dome-shaped head of foliage. As an ornamental alone it is of value, and possesses good possibilities as a street and avenue tree. The fruits greatly resemble in appearance an apple or a quince, and the better varieties are as large as a good-sized apple. When fully ripe the pulp becomes quite soft, and has been described as of a delicious, melting, peach-like flavor. The normal season of ripening is October and November, but as soon as the fruit is fully developed it may be picked and ripened in the house, and is then quite as good as though ripened on the tree.

It should be remembered that the results obtained from this tree in Southern California, both in growth and fruiting, have been produced under the most adverse conditions in practically all cases, and much more can be expected when it is put under proper cultivation.

Of the local trees there are a number which produce small and inferior fruits, worthless or of little value. This is the case with the old tree in Santa Barbara, referred to above, but there are a few which have produced fruits equaling many of the best grown in Mexico, and although it would probably be possible to obtain better varieties by going to Mexico for them, those described are well worth propagating.

Propagation and Culture

Probably the principal reason for this fruit never having been brought into general cultivation in California lies in the fact that its propagation has been but imperfectly understood, and as it does not come true from seed it has been impos-

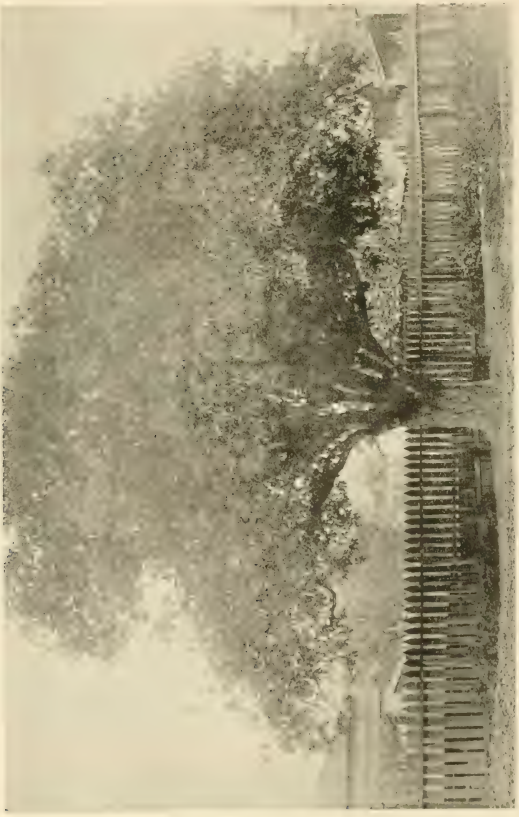


Figure 31. The first White Sapote tree planted in California and probably the oldest tropical fruit tree in the State.

sible to perpetuate the superior varieties. It is doubtful if much experimenting has been done in the propagation of the White Sapote by budding or grafting, but it seems reasonable to believe that it will not be long until our nurserymen will be propagating it in this way, and when this is done and standard varieties established, it promises to appear in general orchard plantings along with such fruits as the avocado and mango.

Quite a number of trees have been grown from seed in recent years and disseminated by nurserymen, and the propagation of the tree in this way is a very simple matter. The seeds do not retain their power of germination for a great length of time after being removed from the fruit, and should be planted as promptly as possible. No special treatment is necessary, and the seedlings make a rapid and vigorous growth under favorable conditions. The seedlings are very much inclined to spindle. I have seen many which have grown to a height of ten or twelve feet before branching, and to avoid this it has been advised to pinch out the terminal bud when the tree has attained a height of two or three feet.

The tree will certainly tolerate a great amount of harsh treatment and still thrive, as is emphasized by the behavior of many of the local trees which have had no cultivation or irrigation for years, and still bear regularly and profusely and are in a flourishing conditon. This drought resistant quality makes the tree very valuable for locations where there is an insufficient supply of water.

The question of hardiness has probably never been definitely settled. In his Dictionary of Gardening Nicholson predicts that it will prove hardy in Ireland and the south of England, and no amount of frost that has occurred in Southern California has been sufficient to injure even the youngest seedlings. Doubtless it will prove hardy practically all over the state. According to Von Mueller it is found in Mexico up to heights of 7000 feet, which certainly goes to show that it is adapted to a cool climate.

A second drawback to its being more extensively planted has been the fact that the seedling trees do not come into bearing until eight or nine years old, but this is a difficulty which will doubtless be eliminated through the propagation of the tree by some vegetative means.

Variations and Varieties

Like most other fruits grown from seeds, the White Sapote is subject to considerable variation. With the local trees no two have produced fruits exactly alike, and there are even marked differences between fruits on the same tree in many instances.

Especially is this variation noticeable in regard to size. None of the trees which I have observed produce fruits of anywhere near uniform size, but this is probably due in a large measure to lack of cultivation and irrigation. For many years the old tree in Santa Barbara was the only fruiting White Sapote in California, and it produced fruits no larger than a cherry. This is doubtless the reason that in early accounts of this species the statement is made that the fruits are from one-half to one inch in diameter. The trees which have come into bearing more recently have produced much larger fruits, in many cases up to the average of the fruits grown in Mexico.

One of the greatest differences between the several varieties here described is in regard to the seeds, their number, form and development. While the number is given as five in all botanical works, in one of the local varieties I have been unable to find even a trace of more than three; in another variety six is not uncommon. In many fruits the seeds do not all attain full size, there sometimes being only one fully developed, while the others are all more or less undeveloped. I have observed this same peculiarity in some of the fruits grown in Mexico. Dr. Franceschi informs me that he has never been able to find any perfect seeds at all in the fruits of the old tree at Santa Barbara. Only one variety which I have seen, the Gillespie, is normal in this respect. In this variety the seeds are invariably well developed, uniform in size, and of good germinating power. In the Parroquia two normal seeds are common, and only one is of not uncommon occurrence, there being but a small, thin husk to show the presence of the other seeds.

There are several other points in which variation is usually shown; in form there is considerable difference, and while the majority of the fruits are round, there are also oval varieties and many trees which produce malformed or abortive fruits, of practically no value. In color there is also considerable variation, and as the highly colored fruits are naturally the most attractive, these would be the most desirable for market purposes. The finer varieties grown in Mexico all possess fairly good color, and in this respect the Harvey is all that could be desired.

There is much difference in the quality of the fruits produced by different trees, and this is, of course, one of the most important points, if not the most important of all.

Much could be done to improve this fruit by selection and crossing; the number of seeds could be reduced, or the seeds eliminated entirely; the flavor could be improved, and a fruit could be produced combining the good points of several varieties and eliminating the bad ones. It is to be hoped that the White Sapote will be given more attention in the future; it certainly merits a more general cultivation, and to the plant breeder it presents very attractive possibilities.

Description of Varieties

Of the numerous trees now fruiting in Southern California, the following are some of the best, and show sufficient differences to warrant being considered distinct varieties.

As has been previously noted, there is considerable variation among fruits on the same tree, and this fact has made it impossible to give a description of a variety which will fit every fruit produced by that tree. Especially is this true in regard to size, there being a great range in this respect on almost every tree. In the following descriptions the dimensions of an average, well developed fruit are given.

Synopsis of the Varieties

A. Form round; diameter three to three and a half inches; cavity shallow to medium, apex more or less extended, five furrowed.

B. Skin smooth, very thin.

C. Color yellowish green, with bright orange cheek.

D. Flesh cream color to pale yellow.

E. Seeds normally five, slightly pointed on one end, two to four, more or less undeveloped. *Harvey*

BB. Skin rather tough, thicker.

C. Color light green, with russet cheek.

D. Flesh white.

E. Seeds five or six, blunt, all perfectly developed. *Gillespie*

AA. Form oval; diameter two and a half inches; cavity none, base slightly extended; apex broadly furrowed with one deep furrow, sometimes two or three others less distinctly defined.

B. Skin smooth, thin.

C. Color yellowish green, self colored.

D. Flesh creamy white.

E. Seeds normally three, long and pointed, one or two more or less undeveloped. *Parroquia*

Figure 32. The Harvey White Sapote, grown at Sierra Madre.

Harvey

(Figures 32 and 33)

This is growing on a vacant lot at Sierra Madre, and so far as I have seen is our largest and most highly colored variety. Possibly it has not as fine a flavor as the Gillespie, but the proportion of seed to fruit is considerably less than in the latter variety, and the fruit is larger and presents a more attractive appearance. Dr. Franceschi states that this tree was raised and planted in its present location by J. C. Harvey, formerly of Los Angeles. In and around Los Angeles are a number of other trees raised by Mr. Harvey, probably from the same batch of seed, and these all produce fruits very similar in general characteristics, so much so in fact that they could not be considered as distinct varieties. But as most of them are inferior, in size at least, the Harvey is the only one of the lot I have considered it worth while to describe.

Description—Form round; diameter three and one-half inches; base somewhat flattened; cavity medium deep, rounded, regular; stem very stout; apex extended to form a nipple, quite prominent, distinctly marked with five shallow grooves; color yellowish green, when fully ripe coloring on one cheek to orange yellow; surface smooth, undulating; dots few, large, rounded, dark brown; skin very thin and delicate; flesh cream color, deepening to creamy yellow near the skin, and becoming very soft; carpels normally five, sometimes four or six; seeds normally five, somewhat the shape of an orange "quarter" but shorter and thicker; broad, slightly pointed on one end, compressed, surface vermiculate or reticulate, one or more of the seeds usually small, thin and undeveloped; flavor good, season October, at Sierra Madre, California.

Tree is upright, open headed, and a very prolific bearer. Here first described.

Figure 33. The Harvey White Sapote tree grown at Sierra Madre, California.

Gillespie

(Figure 34)

This variety is growing on the Gillespie place at Montecito, near Santa Barbara. Dr. Franceschi states that the tree was planted by the late Kinton Stevens in 1892. While not so large or attractive in appearance as the Harvey, it is probably the finest flavored of the local varieties. It is quite distinct from the others in having a rather rough, russet exterior, and perfectly developed seeds.

Description—Form round; diameter three inches; base only slightly flattened; cavity shallow, rounded or flaring, regular; stem stout; apex very slightly ex-

tended; basin deep, narrow, abrupt, deeply five folded; color pale green, one cheek overspread with russet; surface rather rough; dots very numerous, small, irregular, raised russet; skin thin, rather tough; flesh white, becoming tinged with pale green near the skin; flavor very good; carpels normally five, sometimes six; seeds five or six, short and broad, blunt, surface vermiculate or reticulate; season October to November at Montecito, California.

Tree is upright, open headed, very prolific bearer. First described here.

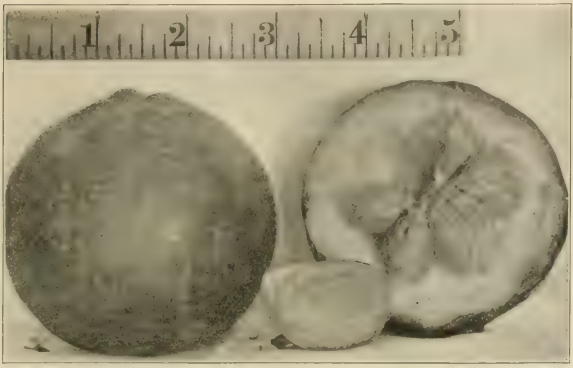


Figure 34. The Gillespie White Sapote, grown at Montecito, near Santa Barbara.

Parroquia

(Figure 35)

This is growing behind the Catholic church on State street in Santa Barbara, and was raised by Dr. Franceschi from Mexican seed and planted in its present location in 1896. So far as I have seen, it contains but three seeds, one or more of which are usually undeveloped, and it also differs materially in form from the other varieties here described.

Description—Form oval; dimensions, diameter two and one-half inches; length three inches; base slightly extended; stem rather slender; apex normally broadly furrowed with one deep furrow, and usually two or three others less distinctly defined; color yellowish green, self colored; surface smooth; skin thin, tender; flesh creamy white; flavor very good; carpels normally three; seeds normally three, one or two usually small, thin and undeveloped, long, pointed on both ends, surface vermiculate or reticulate; season October to April at Santa Barbara, California.

Tree is upright, open headed, fairly prolific. This is the first description of this variety.

The following are some of the principal bibliographical references on the White Sapote:

1884—Von Mueller, Select Extra-Tropical Plants, p. 74.

1895—Franceschi, Santa Barbara Exotic Flora, p. 26.

1899—Rose, Notes on Useful Plants of Mexico (Contributions from the U. S. National Herbarium, Vol. V), p. 217.

1905—Conzatti, Generos Vegetales Mexicanos, p. 163.

1907—Wickson, California Fruits, p. 339.

Figure 35.—The Parroquia White Sapote, grown at Santa Barbara.

Acacias for the Southwest*

BY E. H. SPOOR, REDLANDS, CALIFORNIA

Among all the trees and shrubs that are grown in the temperate and subtropical zones, there are probably none so highly decorative and ornamental as the Acacias. This genus came originally from Australia. It is one of the largest known, comprising about four hundred species. The conditions being similar to their native country, they thrive, and are able to reach their very best development here. They are easily raised from seed, and are quite hardy and vigorous growers.

The Acacias are adapted to many uses. The plants vary widely in form from dwarf shrubs to gigantic trees; also ranging from wide spreading shrubs, such as *cultriformis*, to the most symmetrical tree, as the *melanoxylon*. Some usually have the phyllodes or blade leaves, while others have the bipinnated or feather leaves. A great many are useful as street trees; some beautify the lawns; others make fine hedges. The blossoms differ in form from minute globules to long cylindrical spikes, and in color from a creamy-white to a deep orange. All are abundant bloomers. Some of these do well along the coast in the poorest land nearly in touch of the salt spray, while others meet the demands of the hot interior valleys. Being hardy these grow after a start with practically no care at all; but if given a small amount of care and plenty of water, it is astonishing the way they grow. The Acacias possess an enormous range of foliage forms, and may be so arranged as to give constant succession of bloom the year around. Thriving with the greatest of success they are indispensable in the gardens or on the street.

Propagate by seeds sown between March and August; the earlier started the better. The seeds should be soaked twenty-four hours in hot water before planting. Plant in large pots or flats, with light soil and drainage. Cover with one-eighth of an inch of soil, mixed half in half with sand, with a limited admixture of wood ashes. They will be from a few days to two or three weeks in sprouting. As soon as they are up, prick out into flats or small pots. They should be shaded, but given all the sunlight they will bear. The greatest care should be exercised in watering. Keep moist, but not wet, or they will be likely to "damp off." If grown in pots until they are from two to four feet high, they will do much better when set out. Some varieties which grow much faster than others will be ready to set out the following spring, but generally they are too small until the second spring. If given plenty of water when set out they will make remarkable growth.

The following are lists of all species used and where they may be obtained; also detailed lists for the different purposes:

Seeds Offered by Southern California Seedsmen:

Acacia acinacea.
A. albicans.
A. armata.
A. baileyana.
A. cavenia.
A. cultriformis.
A. macradenia.
A. melanoxylon spectabilis.
A. mollissima.
A. myrtifolia.
A. neriifolia var. floribunda.
A. notabilis.

A. cyanophylla magnifica.
A. cyclops.
A. dealbata.
A. decurrens.
A. elata.
A. extensa.
A. falcata.
A. glaucescens.
A. juncifolia.
A. longfolia.
A. longfolia var. floribunda.
A. longfolia var. latifolia.
A. longfolia var. linifolia.
A. lophantha.
A. obliqua.
A. penninervis.
A. pinifolia.
A. podalyriaefolia.
A. pravissima.
A. primrosa.
A. pulchella var. grandis.
A. pycnantha.
A. retinodes var. floribunda.
A. salicina.
A. saligna.
A. spectabilis excelsa.
A. suaveolens.
A. verticillata.

Further additions offered by Haage and Schmidt are:

A. drummondii.
A. giraffe.
A. leucophylla.
A. paradoxa.

In addition to these Vilmorin offers the following:

A. arabica.
A. calamifolia.
A. catechu.
A. diffusa.
A. eburnea.
A. elongata.
A. farnesiana.
A. grandis.
A. horrida.
A. julibrissin.
A. lebbek.
A. lophantha.
var. neumanni.
var. speciosa.
A. microbotrya.
A. moluccana.
A. nemu.
A. nilotica.
A. obtusata.
A. odoratissima.
A. procera.
A. stenophylla.
A. trinervis.
A. vestita.

Santa Barbara nurserymen also offer living plants of the following:

A. accola.
A. aneura.
A. corymbosa.
A. dietrichiana.
A. flexicaulis.
A. leptoclada.
A. stricta.
A. subulata.

LISTS SHOWING THE DIFFERENT PERIODS OF FLOWERING

Spring:

A. armata.
A. baileyana.
A. dealbata.
A. longifolia.
A. melanoxylon.
A. mollissima.
A. podalyriaefolia.

Early Summer:

A. cultriformis.
A. cyclops.
A. pycnantha.
A. verticillata.

Fall:

A. calamifolia.

These are varieties that have flowered in this vicinity. More extensive lists will be published later, as young, new specimens come into bloom.

LISTS ACCORDING TO ACCEPTED USAGE

Those among the best for street trees are as follows:

A. baileyana.
A. decurrens.
A. dealbata.
A. melanoxylon.
A. mollissima.
A. longifolia.
A. floribunda (A. neriifolia).
A. latifolia.
A. lophantha.
A. pycnantha.

The best lawn specimens are:

A. armata.
A. cultriformis.
A. baileyana.
A. floribunda.
A. lineata.
A. riceana.
A. cyclops.
A. podalyriaefolia.
A. verticillata.
A. latifolia.
A. linifolia.
A. longifolia.
A. albicans.
A. cyanophylla.

Excellent species for hedges consist of:

A. albicans.
A. armata.
A. cavenia.
A. diffusa.
A. pulchella grandis.
A. suaveolens.
A. vestita.
A. verticillata.

Figure 36. Acacia melanoxylon on Grand avenue, Pasadena.

Acacia melanoxylon

(Figure 36)

This Acacia, commonly called the "Blackwood," is a favorite tree for street planting, although not one of the most beautiful. It is an erect pyramidal grower, reaching the height of eighty to a hundred feet. Its popularity for street planting is due to the fact that it is such a symmetrical grower. A peculiar feature of this tree is that when young it has both "blade" and "feather" leaves, and the new shoots have the same feature, although the "blades" are not true leaves. It is a very good hardwood, and is used by cabinet makers. This tree also forms a magnificent dark background for dwarf and brighter blooming varieties. It flowers in March.

Acacia longifolia

(Figure 37)

This is the golden wattle tree; beautiful for street planting or for the lawn. A quick growing variety reaching the height of thirty or forty feet. It has a spread-

Figure 37. Acacia longifolia.

ing habit which makes it very desirable for lawn planting. The golden spikes bloom from February to May. The bark of this tree contains some tannin and the wood is used for various purposes, having light, hard, and tough timber. This is one of the most extensively planted species, and is one of the best, containing several varieties.

Var. *Sophorae*—the pods of this are curled more, the leaves smaller, and it blooms later than the true *longifolia*. It attains a height of twenty or thirty feet in a few years.

Figure 38. Acacia dealbata.

Acacia dealbata

(Figure 38)

The silver wattle; very ornamental, and one of the best for street planting. It has fern-like, glaucous foliage with golden yellow flowers which bloom profusely in early spring. It is a rapid grower, and becomes fifty or sixty feet high. This is largely planted in California, growing very fast when young.

Figure 39. Acacia Baileyana.

Acacia Baileyana

(Figure 39)

This is one of the best and most beautiful of all the Acacias. It unfolds its great bundles of canary yellow flowers early in January, with a contrast of crowded silver green foliage. These flowers completely envelop the tree. It grows rapidly when planted out. After attaining the height of twelve or fifteen feet, it perhaps grows more slowly until it reaches its full height at thirty feet. This is an excellent species for lawn planting, and a beautiful street tree. The bark of this tree is said to contain some tannin.

*In the East our people used to know the different common kinds of oaks, ashes, maples, and other trees, with great familiarity from their earliest childhood. Coming to California they find their familiar oaks and maples replaced by the acacias and eucalypts—strangers from Australia and the Far East, and it takes a very long time to become familiar with the many sorts which are commonly planted here. Mr. Spoor is giving us a simple account of some of these things with illustrations and descriptions by which they may be easily recognized. In working up these articles he acknowledges his indebtedness to all previous writers on the subject, and especially to Messrs. Popenoe, Cornell, and Pierce, for the photographs.—Ed.

Plans and Plants for Small Places

R. D. CORNELL,* LONG BEACH, CALIFORNIA

The greater number of the common trees and shrubs, found in our Southern California home grounds and parks, are not natives of this country, but have been brought in from tropical and subtropical countries and acclimatized here in a new environment. They come largely from Australia, New Zealand, Mexico, Central and South America and West Indies.

The public in general knows nothing of them as to general characteristics, such as genus and species, habits, size of growth, etc.; the park men in general know little of their plants but the proper care of their physical needs; and all too frequently, the nurserymen, entrusted with the propagation and care of the young seedlings, are inaccurately and inadequately informed as to the true names and true characteristics of the goods which they deliver to the public as correctly named. There are no parks or gardens in all our southland where the plantings are named and labeled, so that a stranger might inform himself as to the identity of that tree or shrub which pleased or displeased him.

That which is necessary to develop the greatest charm and beauty of our future California, is a more careful consideration, on the part of the small as well as the large home-builder, in the selection and arrangement of his plantings. It will take but little time and thought and often will save expense in construction as well as add to the selling value of the property.

In the first place, know what you are planting! Be sure of its identity by obtaining it from a reliable nurseryman or other authentic source. Then learn its habits and mature size by noticing some old specimens in your community, or referring to a written authority on the subject, such as "Bailey," found in all good libraries. Now plant the young tree with a view to what it will finally become in size and form, not merely considering how it now looks. Have, if possible, the vision of your home ten years hence, and in laying out the grounds and arranging the plantings you will avoid that crowded, overgrown appearance that is so commonly seen in places, ranging from the small lot to the park measured by acres.

A good creed for the prospective planter is this:

Think, investigate, look beyond today, mix with your selection and arrangement of plantings, your natural common sense, and your investment of a little time and pains will pay an interest of enjoyment, satisfaction and increased value of the property through all the years.

The accompanying half-tones are from photographs taken of Southern California homes. The pictures were best seen from the sidewalk, where the street

*Mr. Cornell has been making a business of visiting plantings of every description throughout Southern California, identifying the plants used, and observing everywhere the varying degrees of wise and unwise usage of them. This seems to me an unexcelled opportunity for all owners of plantings who are not certain of the identity and possibility of their plants, to call upon Mr. Cornell's services. The expense would be slight and it would give an effective answer to the thousands of questions that are constantly being asked, especially by newcomers to Southern California.—Ed.

trees did not interfere with the view, but it was necessary in order to get the entire yard in focus, to take the photos from across the street, even though the trees partially obstruct the view.

The first two views represent two extremes in the methods of treating the small, city lot, in which the house is necessarily close to the sidewalk. The one might be regarded as a chaste example of planting, the other as very florid.

The first home (Figure 40) gives a pleasing effect to the eye. In the window box are ivy-geraniums, while an Asparagus Sprengerii is hanging above them; suspended under the porch are Asparagus Sprengerii in hanging pots and two potted yuccas are seen on the buttresses; a well kept geranium hedge reaches to the porch floor and hides the foundation; to the left, in the background, are lemon

Figure 40. Showing a narrow front yard well planted by being little planted. Some shrubbery might be well used at the sides.

trees. Aside from these, there are absolutely no plantings; nothing to obstruct the view, either from within or without, and give that overcrowded, cramped appearance which is so commonly seen.

The second home (Figure 41) though comfortable and attractive, is the opposite extreme. At the right, is an immense Yucca gloriosa, cutting off the view of that corner of the house and flaunting its bare, unsightly trunk before all passers-by, while beside it, several trees are crowded into altogether too small a space.

On the left, the same fault is to be found. There, are seen an immense pepper tree, a banana, a Sterculia and a bamboo, all in a space inadequate for the pepper alone. Then, too, the Sterculia and bamboo are placed where, within a few years their growth will entirely shut out both the sun and the view.

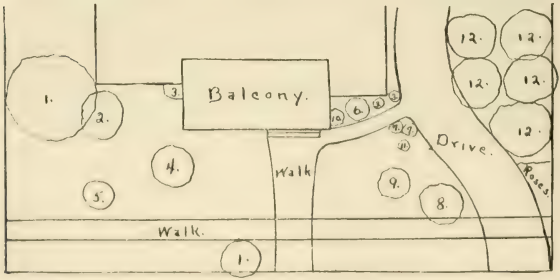


Figure 41. Showing a place somewhat floridly planted, with note-book sketch showing plants used, as follows: 1, Schinus molle; 2, Banana; 3, Tree fern; 4, Sterculia acerifolia; 5, dwarf Bamboo; 6, Yucca gloriosa; 7, Aralia papyrifera; 8, Acacia Baileyana; 9, Pittosporum eugenioides; 10, Hydrangea; 11, Elephant-ear; 12, Oranges. Nos. 4 and 9 are due to become good sized trees.

The effect of the vine covered porch is, however, very pleasing. The climbing fig *(Ficus repens)* is kept well trimmed and in bounds and the porch is seen to contain hanging ferns and potted begonias. There are also potted ferns on the buttresses and a giant tree fern at the left end of the porch.

The last two cuts (Figures 42 and 43) are different views of one and the same home. Might the street trees be cut from the scene, it would be a beauty. Here, there are no large plantings in front of the house, but the trees and shrubs are banked at the sides and in such a way as to hide the rear of the lot and still add to the attractiveness of the place.

The rose-covered pergola at the left, with the pepper at its end, balances and neutralizes the effect produced by the group of trees at the right. In this case, as in the others, the porch is hung with ferns, and potted ferns are on the buttresses.

Figure 42. Front view of same place shown in Figure 43.

A bank of heliotrope planted against the foundation of the porch helps greatly in softening the lines.

None of these views can be appreciated, either as examples of good or bad, unless actually seen in the freshness of life and color. But we have here attempted to give our readers some idea of what can or cannot be done with a small home by means of these actual examples.

The accompanying diagram (Figure 44) is representative in part of the manifold possibilities which present themselves for the beautification of the ordinary city residence lot. The plate represents a corner lot and is constructed on the supposition that an alley runs along the rear; and the lot is planted and arranged for a west frontage with an open exposure on the south.

This plan is such as could easily be carried out by the home builder of moderate means, with no additional expense than is ordinarily put on the construction

of and the too often futile attempts at beautifying the grounds. If the owners of city homes would give the matter of plantings and arrangements of walks and drives a little consideration, and not merely put what they want wherever it seems to fit in most conveniently at the time of planting, there would be a marked improvement in the appearance of our California homes.

The essential steps are: First, to consider the conditions, such as direction of frontage, surroundings, contour, shape and size of lot, and the shape, size and

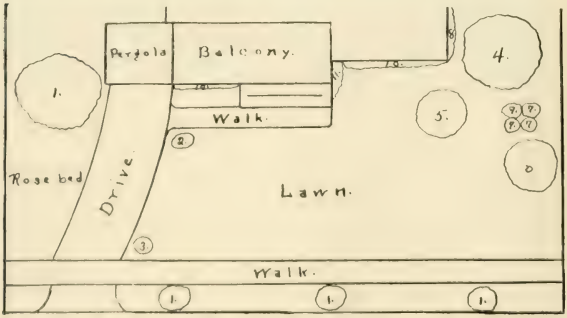


Figure 43. Quartering view of a well planted place, with note-book sketch of plants used, as follows: 1, Schinus molle; 2, Grevillea Thelmanniana; 3, Yucca gloriosa; 4, Acacia floribunda; 5, Acacia Baileyana; 6, Araucaria Bidwilli; 7, Aralia papyrifera; 8, Wigandia; 9 Wigandia; 10, Heliotrope; 11, Elephant-ear.

number of buildings to be placed in the given space; second, construct any drives or walks; third, decide on the plantings which are desired and which are adapted to the environment, and fourth, arrange these in an artistic manner, not in a conglomerate mess. Pre-consideration is the foundation principle of all pleasing landscape effects.

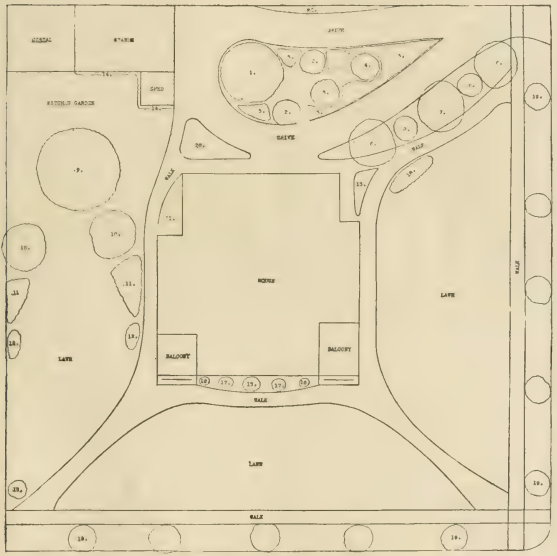


Figure 44. An original plan showing some of the fine possibilities in a corner place. The plants used are as follows: 1, Magnolia grandiflora; 2, Lagerstroemia indica; 3, Eugenia latifolia; 4, Spiraea thunbergii; 5, Lantana; 6, Phœnix canariensis; 7, Cocos plumosa; 8, Cycas revoluta; 9, Eucalyptus viminalis; 10, Acacia decurrens; 11, Chilopsis saligna; 12, Mimulus glutinosus; 13, Calochortus; 14, Ficus repens; 15, Grevillea Thelmanniana; 16, Heliotrope; 17, Fuchsia; 18, Poinsettia; 19, Jacaranda mimosaefolia; 20, Guavas.

A Botanic Garden for Southern California

C. F. BAKER, POMONA COLLEGE, CLAREMONT, CALIFORNIA

Southern California has very justly been called the Garden Spot of Earth! No other similar region is so rich horticulturally, and none other possesses more striking undeveloped possibilities. With such a debt to Horticulture one would expect to find here marked evidences of more than ordinary interest in plants, in botany, and work pointing to wider development and better knowledge of all of the possibilities involved. Comparing the extent and character of our horticultural interests with those of other countries, even some of those far beneath us in civilization, we find here a remarkable paucity of live interest and real activity along these lines. Southern California has taken only a first step as yet in the building of great public parks, and many of our good sized towns have none at all.

In numerous other regions scarcely larger, or even smaller, than this, and with smaller horticultural resources, like Java, Trinidad, Ceylon, Jamaica, or England, and in many of the still smaller countries and colonies, we find great, scientifically managed, and beautifully arranged Botanic Gardens, with extensive botanical and horticultural libraries attached thereto. In such places are gathered all of the thousands of plants of interest and importance to the region, where they may be definitely known by name, where people generally and all growers, fanciers, nurserymen, and others specially interested may visit them at any time, learn to exactly know them, and to examine all of the literature relating to them. In addition to its other possibilities, in such a garden thousands of new things can be introduced and acclimatized, and then thousands of cuttings and packets of seed of desirable things distributed among our people.

The mind leaps at once, in looking over the work of these great projects in other countries, to the tremendous possibilities such an enterprise might have here, in these most favorable surroundings, in both material and educational ways. We have but very few such institutions in the whole United States, like the Arnold Arboretum in Massachusetts, the New York Botanic Garden supported by men of wealth in New York City, and the Shaw Gardens in St. Louis.

Prof. Cook and I have persistently agitated this highly important project and have even tried to interest people at Pomona College in the matter. Pomona College possesses one of the finest parks in the South, of sixty acres and all undeveloped as yet. It might easily be made a most powerful educational tool, and still be a thing of beauty, though it seems more likely to develop into merely a pretty picture for passing pleasure, like so many others of our public parks. We have got to make something more than that out of our parks if we wish them to mean the most to our people, and yield to them the greatest possibiilties.

Even here at the College, without any support, and by personal enterprise alone, we have begun the development of a Garden and have already a collection from all parts of the world of some 25,000 plants in pots, all carefully named, but with no space to plant them out where they will be cared for, and we have in the meantime given away above 10,000 plants and many hundreds of packets of seed,

all gratis. Even all this is, under present conditions, no promise at all that it will be possible to accomplish anything permanent whatever at Claremont. But it is a most important and illuminating practical demonstration of how easily and rapidly such an enterprise might be developed with even moderate support.

Above all things, the enterprise should be *organized and permanently established*, and it will then, surely and rapidly, become one of the most valued possessions of our commonwealth. It could be accomplished anywhere with energy and enterprise, even at Claremont. The people of Southern California want it. Many people throughout the South with whom I have talked concerning it, have spoken of the need of it most earnestly, but their voices have not yet been raised in unison. *Standing together,* our people could have the best and most efficient thing of the sort in the world.

Our experiment in botanic garden building here at Claremont, has amply proven the point we wished to make in connection with it, and that is, that with even a small amount of intelligent direction, great results can readily be accomplished with very limited support, or, as in this particular instance, with none at all, since we have made the work practically support itself. One should now look over these thousands of lusty young plants of interesting and valuable species from all over the world, produced here without hired help and under very unfavorable circumstances, to gather some idea of the really great developments along this line that might be obtained through friendly interest, and even limited support.

We have here shown, conclusively, the ready possibility of producing an unlimited variety of the world's most interesting and valuable trees, shrubs, and herbaceous plants, with wholly trivial effort and expense. If this could be matched with a provision of space for plantings, and a competent Curator, a great Botanic Garden would become an immediate reality.

Fungi Nova, Vivenda Citrus*

DR. H. REHM, MUNICH, GERMANY

Ad folia *Citrus Aurantii* cultivatas, Corona et Claremont, Californiæ, 1, 1911; leg. C. W. Metz et J. A. Prizer.

I. In plagis foliorum vivorum late expansis, longitudinaliter nervorem medialem amplectentibus ambientibusque, plane exsiccatis, papyraceis, flavide albescentibus, curvado-flavorubidule marginaceis arcte gregaria innati, plagulas cinerascentes reddentia, imprimis paginæ inferiore folii, perithecia globulosa, glabra, nigra, pro minutissime perspicue pertusa, papillula perexigua demum prominentia, parenchymatice fusce contexta, 0. 1 to 0. 15 mm. diam. Asci lageniformes, basi lata sessiles, versus apicem cylindraceo-elongati, 50 to 60 micromm. longi, in parte inferiore 20 micromm., ad apicem 10 ulati, 8 spori. Sporæ subclavatæ, utrinque rotundatæ, medio septatæ(paullulum constrictæ, utraque cellula i guttata, hyalinæ, 20 to 7 micromm., in parte inferiore asci plerumque sitæ. Paraphyses nullæ.

Mycosphaerella lageniformis Rehm.

II. In iisdem plagis, a *M. lageniformis* late absessis, nec distincte separatis, sed plus minus ne albidulis hic illic subgregaria innata perithecia globulosa, paginam inferiore folii elevantia ab eaque tecta, demum dirrumpentia, minutissime papillulata, glabra, excipulo sclerotioideo, duro, extus fusco, intus hyalino praedita, 0. 2 to 0. 3 mm. diam. Asci clavato-cylindracei, crasse tunicati, vix stipitati, apice rotundati, 110 to 130, 20 to 22 micromm., 8 spori. Sporæ ovoidæ, utrinque obtusæ, medio constrictæ, transverse 3-, longitudinaliter exclusis cellulis apicalibus 2-septatæ, subfuscæ, 22 to 24, 10 to 12 micromm., distichæ. Paraphyses haud con-

Scleroplea Aurantiorum Rehm.

Von Hohnel—Pragm. Myc. IV, in Ber. kais. Ak. Wiss, Wien, Bd. CXVI, Abt. I. p. 136 claris verbis descripsit definitionem *Sclerophcae* (Sacc. Syll. II, p. 277). Oudem. (cfr. Sacc. Syll. XVI, p. 548), generis *Pseudosphaeriacearum*, imprimis Pleosphæriaceis alienum contextu sclerotiadeo, stromatisco, sine paraphysibus contexto. Peritheciæ hujus generis sclerotiacea certe per longum tempus viva, itaque valde noxia evadere possunt, non minus perithecia *Mycosphaerellae lageniformis* luxurie imprimis sporarum.

Observatione accurata foliorum vivorum mox in lucem prodibis, cujus harum specierum parasiticarum invasione primordia destructionis foliorum prodibis, mihi videtur *Mycosphaerellae*. Utraque species valde noxiæ fere mihi videtur.

*Dr. Rehm has very kindly drawn up the formal diagnoses of these two interesting new fungi, living on Citrus. One of them, at least, is purely saprophytic. Mr. Metz is preparing drawings of them, and also further notes, which will be published later. These two fungi are of special interest on account of their occurrence on spots ordinarily attributed to wither-tip.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume I SEPTEMBER 1911 Number 3

The Withertip Disease in Florida

P. H. ROLFS
DIRECTOR OF THE FLORIDA AGRICULTURAL EXPERIMENT STATION

In the article on Withertip in the first number of the Pomona College Journal of Economic Botany there has been brought together a very complete and forceful resume of this subject as we now know it. Our laboratory experiments with pure cultures show conclusively that withertip fungus is able to infect healthy, uninjured tissue not only of oranges but of a number of other sub-tropical fruit trees. Naturally the disease is more serious on trees whose constitution has been weakened by other untoward conditions. Consequently, the average grower, whose opportunities for observation and close study are more limited than those of the plant pathologist, is entirely justified in coming to the conclusion that the withertip fungus is a secondary parasite.

In regard to the red spots of an anthracnose-like character which frequently occur on citrus fruits, I may say that mistakes are frequently made. We know that the resultant lesions from certain chemical poisons on fruit are so like those produced by the withertip fungus that they are not easily distinguished even by use of a compound microscope. In pronouncing a case anthracnose, therefore, the experienced plant pathologist does so with a great deal of hesitation unless he is very familiar with the surrounding conditions. For instance, I should hesitate very much in pronouncing a lesion due to withertip by examining a specimen of fruit only, due to the fact, which I have described above, that chemicals are known to produce lesions that are very similar to the withertip lesions on mature and nearly mature fruit. In the groves, however, and where all the surrounding conditions are known to the plant pathologist, he should be able to make a diagnosis without much hesitation.

I was very much surprised during my visit in California by the frequency with which I met this fungus. In most of the cases it was simply hanging around in the groves and doing very little damage, and no one but a person who was familiar with the fungus at first-hand would have suspected its presence.

In our early studies of the withertip fungus we laid a great deal of stress on the use of Bordeaux mixture. Our later and more exact work has enabled us to treat the disease very successfully without the use of this spray. Everybody who has had experience with Bordeaux mixture on a large scale knows that it is a very disagreeable material to handle. In Florida, also, our friendly fungi hold the scale insects so much in check that we hardly need to spray for them. By using

Bordeaux mixture we kill this friendly fungus and thus allow the scale insects to increase with unusual rapidity.

Our best method in Florida consists in thorough orchard sanitation followed by vigorous pruning out of the withertip affected branches. This pruning out is done most profitably during July and during January. It is during these months that our trees are pretty certain to be in full dormancy. Pruning out for withertip when there is much new growth present is a very bad practice since every scratch on the leaves or abrasion on the young growth makes it very liable to withertip infection and the spores must be present in the infected groves by the myriads.

Notes on *Scleroplea aurantiorum* and *Mycosphaerella lageniformis*

CHAS. W. METZ
POMONA COLLEGE, CLAREMONT, CALIFORNIA

The two new ascomycetes described in the last number of this Journal by Mr. H. Rehm are species found in Southern California on orange and lemon trees. The first record of these is from orange leaves taken at Corona, California, by Mr. Prizer of Pomona College. Later the writer found them in orchards near Claremont.

The descriptions of the habit of these fungi, given by Mr. Rehm, are based upon two or three specimens, and are not strictly characteristic. The leaves upon which the fungi are found look almost exactly like leaves affected with withertip, (*Colletotrichum glocosporioides* Penz.) (See "Withertip of Citrus Trees," by E. O. Essig, P. C. Journ. Ec. Bot. 1-25). The yellow, shrivelled areas may be at the tip, edges, or in the body of the leaf, but are invariably bordered by a brown or dark yellow margin. The perithecia of the two, especially those of *Scleroplea aurantiorum*, so resemble the acervuli of the withertip that to the naked eye they are indistinguishable. They never accompany the withertip, however, at least in this vicinity.

Both the *Scleroplea* and the *Mycosphaerella* are often found on the same leaf, but the larger and less congregated perithecia of the former, usually serve to distinguish them. Whether or not they are parasitic is not known. Certainly they are not found on any but living leaves, so far as I am aware. Fallen leaves, and hanging dead leaves, show no signs of their presence; nor do leaves mechanically injured. Likewise weakened leaves on trees attacked by squirrels, or otherwise impoverished, show no signs of attack. On the other hand, the fungi apparently are of no appreciable harm to infected trees, as they occur on very few trees, and do not spread rapidly. The writer has only found them on one or two lemon, and perhaps a dozen orange trees in this vicinity; and only on two of the latter were they abundant. On these two the affected leaves were all on the south side, facing the road, the other parts of the tree being entirely free from infection. From one tree about three hundred leaves were taken in an area of a few square feet. None of the trees surrounding these two showed any signs of the fungi. At Corona Mr. Prizer found one tree on which a large part of the foliage was affected, while at Riverside investigation shows only a few scattering leaves with any signs of it. The tree at Corona is the only one known to me, on which the disease, if such it is, is conspicuous. At any rate the survey has been entirely too inadequate to justify any conclusions as to the economic importance of the fungi, even if they are both parasitic, as Mr. Rehm believes.

The characters of the fungi themselves can best be seen from the accompanying figures (Figure 45) prepared by the writer. These have been drawn to scale, so that an accurate comparison of size and form can be made. The perithecia

of both species are dark, heavy, and thick-walled, but differ greatly in size and position. Those of *Scleroplea aurantiorum* (Figure 45B) are almost entirely below the surface level of the leaf, while those of the *Mycosphaerella* (Figure 45A) are merely beneath the epidermis, rupturing the latter as they grow. The perithecia, asci, and spores of *Scleroplea aurantiorum* are quite uniform in size and

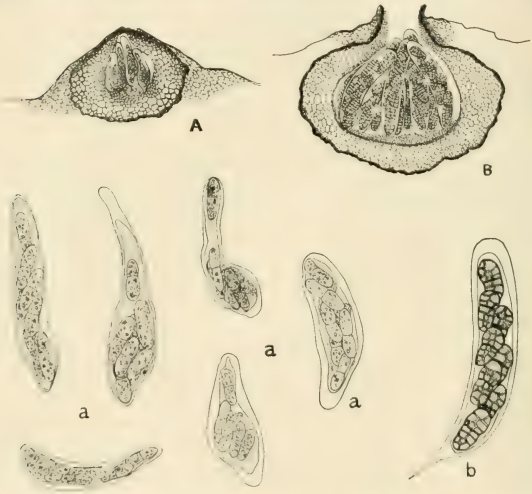


Figure 45. Details of Scleroplea aurantiorum and Mycosphaerella lageniformis. A, a, a, a, M. lageniformis; B, b, S. aurantiorum.

form, as shown in the figures (B and b). The black perithecia, together with the yellowish, opaque spores in the transparent asci, are very striking in appearance. The asci and spores of *Mycosphaerella lageniformis*,* however, are neither conspicuous, nor uniform, although the perithecia do not seem to vary much. The asci may be of almost any shape from the typical flask-shape described by Mr. Rehm, to long, cylindrical. The spores, like the asci, are hyaline and not uniform in size, although they are easily distinguished by their shape and two-celled structure. Something of the variation found is shown by the figures of the six asci given. (Figure 45, a a a).

*A *Mycosphaerella* with similarly lageniform and very variable asci has recently been described by Shirai and Hara under the name of *M. macleyae* from *Macleya cordata* in Japan (The Botan. Magaz. XXV, March, 1911).

Modern Agriculture in Mexico

D. L. CRAWFORD
POMONA COLLEGE, CLAREMONT, CALIFORNIA

Mexico, with its many thousands of square miles of good, arable land, is preeminently adapted to agriculture. There are few countries in the world which have the enormous possibilities of wealth which now lie in the most productive soil of our sister Republic. Our states are producing now immense quantities of cereals and temperate fruits, but Mexico has the natural opportunity to produce not only immense amounts of cereals and temperate fruits but in addition nearly all the standard tropical and subtropical products known to commerce.

The topography of the country is very varied. In the vast northern desert, which will some day be transformed by irrigation, are large sections which by the presence of water are enabled to yield richly in citrus and other fruits, cereals and cotton. The southern and more tropical section has a wide range in climate and soil conditions. There are three recognized divisions: the *tierra fria*, or the inland plateaus and mountain valleys, always quite cold; the *tierra templada*, or the lower table lands, moderate in climate; and the *tierra caliente*, or the hot coast country. Each of these three belts is naturally adapted to totally different forms of agriculture. Each of the three belts is, moreover, adapted within itself to different things. One section of the temperate lands may be best adapted to the culture of fruit; another may be better able to produce good corn. One section of the hot country is best suited to the culture of the *Castilla* rubber tree; another is not fitted for this, but favors the production of coffee, or bananas, or the fibre plants. It is a pitiable thing, indeed, to see in Mexico one prospective planter after another go to ruin just because of ignorance or carelessness in not heeding these laws of natural adaptation of soils.

The time was, not far back, when the products of agriculture were with great difficulty shipped beyond the immediate locality where they happened to be grown. This is no longer true. Railroads are tapping scores of rich areas and making it possible for growers in almost any portion of the country to send their goods not only to the large cities of the Republic but also to the outside world. Three long lines of railway enter the United States and a fourth is rapidly being pushed to completion from Southern California to Guadalajara and Mexico City. Three large shipping centers on each coast, Tampico, Vera Cruz, and Puerto Mexico on the Gulf coast, and Acapulco, Salina Cruz, and Manzanillo on the Pacific, together with many smaller ports, make communication with the outside world comparatively easy. And if a better communication is necessary it only required an active demand for it to bring it about.

As a rule a country tries to produce as much as possible of the articles of food used by its own people. The universal crops of the country are corn and beans, as would be expected since these are the two chief articles of food. These are grown, or at last planted, in nearly all regions and under nearly all conditions of soil and climate. Vast corn fields are planted every year on the extensive plateau-

like mesas around Mexico City, Guadalajara and Puebla, in the high mountain valleys and even on the mountain sides around Orizaba, and Zacatecas, and on the lower lands about Vera Cruz and Tampico and the southern hot lands. In fact one can scarcely travel in Mexico without frequently seeing some sort of a corn field—it may be a thousand acres or it may be a quarter of an acre; it may be in a most flourishing and thriving condition or it may be poor and miserably developed and with almost no yield at all. Every man tries to maintain independence and thinks that he can best do this by actually producing his own corn and whatever other food he may need. Accordingly he plants regardless of surrounding conditions.

There are numerous other products, some agricultural and others growing more or less wild and without cultivation. The chili, or red pepper, is grown quite extensively, since this forms a necessary part of the daily diet. One or more of the many varieties of avocado, or aguacate as it is called, by the Mexican, flourish in all parts of the country and always find a ready market. There are many fruits produced by more or less labor such as the mango, guava, many varieties of the sapote—the sapote blanco, negra, colorado, domingo and others,—the arrayan, papaya, bananas of many kinds, and many other native fruits. A very extensively grown plant is the maguey, one of the *Agaves*, which is grown for the production of the native drink, *pulque*. The sugar cane is produced in large quantity both for sugar and similar products, and also for aguardiente, or alcohol. Pineapples are being planted more and more in the lower and warmer belts, and are found to be very profitable. Citrus fruits have been produced in varying amounts for many years. Oranges flourish in many parts of the Republic and when not infested by the terrible Orange Maggot are a great source of profit. The lemon most commonly produced is the small seedling variety but it is very juicy and acid. The sweet lime finds a ready market always and the large citron is not an uncommon product. Cotton is being tried in many sections of the country, and in some instances the results are most encouraging. Rice is produced in the lower belts and even in the state of Morelos around Ixtla. Alfalfa and other fodders are grown to a considerable extent. Vegetables of many kinds are produced for the local markets. Temperate fruits such as peaches, apples, grapes, pears, quinces, and others, are produced in small amounts, but very poor in quality; these are planted more in the higher and more northern sections where the climate is more or less temperate. Finally we come to the tropical products of southern Mexico—coffee, tea, cacao or the cocoa bean, vanilla, rubber, etc.

As will be seen from this hasty and brief enumeration of products the possibilities in agriculture are not only great but most remarkably varied. Mexico presents by far the most varied and at the same time accessible topography of any country in the world. Almost every climatic, atmospheric and soil condition prevails in some part of the land.

In spite of these remarkable possibilities peculiar to Mexico, very little has been done thus far to realize any of them. Nature has played by far the largest part in agriculture in the past years instead of the agriculturist taking the upper hand, as he has done in other countries, and directing the forces of nature in the

way most advantageous to him, and even avoiding or preventing the evil results of natural occurrences. The very methods employed in the tillage and care of the soil not only fail to secure the best possible results, but are causing actual depletion and exhaustion of the soil. If present methods continue and are not replaced by modern scientific methods of tillage and culture, there will come a time, and it will be very soon, when the virgin strength of the soil is exhausted and then agriculturally the nation will surely suffer.

The many books treating of soil and its care have not been written without careful and scientific investigation and experimentation, and there is not a single authority that would advise the use of a forked stick as a plow. Of course, whether or not oxen are used in place of horses or mules is a matter to be decided by the people concerned. If a man is willing to take ten days to plow with oxen the same area which he could in one day with mules or horses, or even in much less time with steam power, then he is at perfect liberty to do so. All that can be said for that man, however, is that he is practicing poor economy and will sooner or later be distanced by the rapid advance of civilization in other regions. But as to the plow itself, there is a far different question at stake. In order to conserve and increase the plant foods stored up in the soil and to furnish the right amount of moisture to the plant roots a good mulch is essential. This mulch should be made by turning over and pulverizing the surface soil from time to time, the depth to which it is turned varying with attendant circumstances. All that the wooden "plow" performs is to merely push the dirt to one side, or sometimes not even that, and thus only scratch the surface, whereas the steel plow completely turns the surface layers and thus makes available for use the nitrogenous and phosphorous foods formed farther under the surface. This, of course, applies more to the annual preparation of a yearly cereal crop rather than to the regular care of an orchard, although in the latter case it is not out of place. As an illustration of this principle one need only to look at the corn fields near Mount Popocatapetl, north of Popo Park. There the steel plow is in extensive use and the results show it plainly. Acre after acre produces some of the richest corn imaginable, while other fields in the same belt not plowed with the steel plow are greatly inferior in their yield. Fortunately the steel plow is gradually replacing the old worthless wooden plow, but this displacement must surely be hastened and not allowed to take its present too gradual course. It was a great surprise to hear a man, who is actually in charge of one of the government experimental stations, say that he had tried mules and horses and steel plows but that he had found that they did not pay and so had returned to the use of the forked stick dragged along at a snail pace by two oxen. His explanation was that the mules and horses could not endure the intense heat. There is absolutely no reason why these animals may not be perfectly acclimatized in a comparatively short time to endure as much as any native animal, as they already have been in other countries. If an experimental farm persists in using the wooden plow, as is done at Oaxaca and at Rio Verde, what can be expected of the common farmer? If it is high tariff duties on farm implements or lack of possible manufactories for them that is preventing or hindering the use of modern tools, then steps should be taken by the govern-

ment to remove the import duties or else promote the manufacture of them at home; at any rate they surely ought to be offered for sale at the most reasonable price possible.

While it is true that in general these methods are necessary to the best success of agriculture, yet local conditions must always be dealt with individually. Field tillage that would bring about the best results in semi-arid soil might be quite disastrous if applied blindly to a very humid soil. The duty of modern science is to study the conditions affecting the growth of crops in as many localities and under as may conditions as possible, not only in Mexico but in Southern California and everywhere else.

Now let us turn to the methods of culture in orchard and other crops, having seen those employed in cereal field preparation. The first thing one notices on entering so-called orchards in Mexico is that nearly everything is left to the processes of nature. Very little order is observed in the arrangement of the trees and little effort is expended to keep the ground free from weeds. The soil is seldom and poorly stirred, thus hindering seriously the bacteriological processes of plant-food manufacture beneath the soil. Again, fertilization of the soil is almost never thought of. Because of the tremendous virgin richness of the soil the idea is quite prevalent that culture is entirely unnecessary and uncalled for. It has been only a comparatively short time since the California farmer and orchardist has begun to realize that there is a limit to the virgin richness of our soils and that this must be conserved most carefully and most scientifically, since personal welfare as well as that of the state depends very largely upon it. The man who ignorantly causes constant depletion of land or who greedily exploits it to its limit is a menace to the nation, no matter where or who he may be.

Very little or no effort has been made to improve orchard stock by budding, grafting or selecting. What might be done in the way of improving the avocado, for instance, or the mango, by breeding and selection is simply beyond estimate. There is scarcely an avocado tree in the Republic, I venture, that is not a seedling, and hardly a mango or orange tree that was not grown from a seed and left unimproved. It is very good philosophy to be satisfied with what one has, but only when that is the best that one can get. To be satisfied with the products of seedling trees is not in the least necessary since they can be improved and the financial returns greatly increased simply by applying some of the scientific methods worked out in other countries.

The avocado, or aguacate, grows in nearly all parts of the country and occurs in many different varieties all the way from the size and the appearance of a small plum or prune to a large full fruit some six inches in diameter. The meat varies in quantity and quality from poor and insipid to rich and delicious. Yet in spite of the immense range of varieties very little attempt has ever been made to improve them or even select the best. It has been taken for granted apparently that no other variety would flourish in any locality except those that have been there for years. In recent articles on the "Avocado in Southern California" by Mr. F. W. Popenoe the possibilities of improvement from budding and selection are strongly brought out. It is a fact well known to horticulturists the world over

that a large proportion of the seedling trees either never bear any fruit at all or else bear a worthless product, and almost none possess the fertility and fruiting capacity which budded stock does if rightly handled. With proper experimentation under thoroughly scientific control the avocado could be made a source of tremendous profit and benefit. The fruit is so universally a part of the people's diet and at the same time so delicious and nutritious that no expense should be spared to produce the best trees possible by selecting and budding the best varieties. Wealth and great benefit to the nation can be derived from its production not only for home consumption, which would necessarily be great, but also for export. With present methods of railroad shipment it would scarcely be possible to export the large, soft, thin-skinned varieties grown in Chiapas and Vera Cruz states, but beyond all question there is a ready possibility of shipping some of the harder and thicker-skinned varieties such as, for instance, those produced in San Luis Potosi, Coahuila, and in the vicinity of Torreon. These varieties even in their present state are very delicious and with improvement in stock and with best methods employed in handling, packing and shipping surely will find a ready market anywhere in the United States, even after Florida and Southern California become heavy producers, as they will. Rightly managed, the avocado industry can and surely will become a source of great wealth to the country, and the time when this shall come merely depends on the readiness of the people to adopt the best that science has to offer. What better investment could be made than a large and scientifically managed avocado plantation, with only the best and most approved stock planted therein, to produce fruit that would easily take preference over the inferior seedling fruit now offered in the market, and some of which could be shipped with great profit into the United States?

In addition to improving the quality of the fruit and increasing the average yield by budding, another great field lies open to scientific effort, namely, that of reducing the avocado seed to the minimum and increasing the quality of the meat. This can be done by selection and budding. There is no possible reason for doubting that this improvement can and will be brought about not only in the avocado and not only in Mexico, but in all fruits and in all countries. For this experimentation Mexico possesses unequaled opportunities and should easily be the teacher of other countries in tropical and subtropical horticulture.

The mango, likewise, is surely subject to very great improvement by the same methods as outlined for the avocado. The seed, or bone as it is called by the native, is needlessly large and fibrous, and might easily be reduced by selection. Just how much improvement can be effected in this fruit is largely conjectural since almost nothing has been attempted in that line. We are safely within the bounds of truth, however, when we declare that a very great improvement in quality and quantity of fruit can be made, with a greater or less reduction of fibre. The "manila" mango grown at its best in the state of Vera Cruz in the vicinities of Cordoba and Medias Aguas, is certainly a most profitable fruit, and yet it can undoubtedly be made more valuable by applying modern science to its culture. This variety of mango, too, seems to be entirely free from the ravages of the orange maggot, so devastating to the native variety. While the "manila" is larger

and in some respects finer than the native variety, still the latter, known by various names, one of which is *mexicano*, is often preferred by the native and foreigner alike. The large market for both varieties demands that both be improved to their highest point of quality.

As in the case of the avocado, so the mango, also, may be made an article of export to the United States—*but only after the orange maggot has been completely exterminated!* Mangoes have been shipped from the Philippine islands to Pomona College in Southern California, being a month in transit, and yet they arrived in edible condition. If that is possible, exportation from Mexico is readily feasible. Although both the avocado and mango have been produced in Southern California and will be later to a much larger extent, yet there will always be an increasing demand for the Mexican fruit to supplement our own productions.

In a previous paper the possibilities in the improvement of the Mexican seedling orange were brought out. While the seedling orange may be considered by many of superior quality in taste to the navel varieties, yet the latter command a price in the markets from two to five times as large as do the seedlings. The general statements made in regard to seedling trees above apply equally to the citrus group. There is a large market for all the numerous varieties, both seedling and hybrid. One variety may be better adapted to certain soil and climatic conditions than the others, in which case that variety ought surely to be planted.

It was stated at the Oaxaca Experiment Station that trials of budded citrus stock had been made without success, due, it was said, to the inability of the stock to resist frosts and other unfavorable conditions. It is hardly possible that acclimatization might not be effected, thus rendering the improved hybrid varieties just as resistant as the original seedling. This must be proven, however, by careful and extensive experimentation. A good start in this direction is being made in Vera Cruz state at Plantation Roma. This is a citrus orchard of about three hundred acres operated entirely by modern scientific methods. Mr. R. D. Huber, in charge, insists on cultivation by means of steel plows and cultivators drawn by mules. Some budded stock has been planted and a thorough trial of it is being made. Experimentation such as this—on a large and practical scale, experimental and at the same time yielding large returns financially—will surely help to advance agriculture, horticulture and pomology to its proper state.

The same may be applied equally well to the culture of lemons, and all other citrus fruits. The producers should be satisfied with nothing less than the best, and should bend every energy toward bringing about these improvements. And so we might go through the long list of native fruits, pointing out where improvement and resulting financial gain could be effected. Some varieties of the sapote might profitably be grown for shipment. The white sapote, *sapote blanco*, is too soft and thin-skinned to allow of exportation, but the sapote *negro* and sapote *domingo* might easily be shipped. The cherimoya and other fruits, also, can be greatly improved and increased in value.

More or less experimentation is now being carried on in the way of selecting and determining the best variety of *Castilla* rubber tree, the best variety of coffee, the best varieties and adaptability of cotton, the most productive sugar cane, etc.

These efforts are in the right direction and cannot possibly be made too intense. It may even be added that efforts toward crossing and hybridizing in the producing of the best varieties are not only advisable but most urgently necessary. The *Castilla* rubber industry is a new one and still in the experimental stage of development. On the Dona Maria and La Zacualpa plantations in Chiapas every effort is being made to determine which of the several varieties of *Castilla* produces the greatest flow of latex through the greatest proportion of the year. As these experiments are being carried on it will be very easy to try hybrid varieties by every possible combination in cross pollination, until one variety is evolved which without question is the most productive. But it is most important to remember that in two distinct belts the most productive variety may not be one and the same.

Similarly, a variety of coffee may easily be produced which will be resistant to the destructive mildew which is so common on these plantations. The annual loss from this one source alone, the coffee mildew, would more than pay for very extensive and comprehensive experimentation by trained horticulturists. Although one is accustomed to think of the banana as beyond improvement, yet in this field, too, there is vast room for improvement in the way of size, flavor, number of "fingers" to the "hand" and "hands" to the bunch, etc. It is subject to a very destructive bacterial disease in Central America, not far from Mexico, and resistant varieties must be discovered or developed. The immense extent of this industry demands that the yield each year be up to the highest standard possible.

The culture of the maguey, or agave, for pulque manufacture, needs but one thing to make it of great benefit to the nation *–extermination!* Just as the manufacture of intoxicating liquors in the United States or any other country is simply sapping the virile strength of the nation and adding absolutely nothing in the way of productive labor, just so does the very extensive culture of the maguey add nothing of productivity and, moreover, it is sapping the life blood of the under class of the nation. One of the great sources of income in the state of Yucatan is the henequen fibre plant, belonging to the same genus, *Agave*. At the National Museum of the commission of biological survey in Tacubaya, Federal District, there are samples of the fibre produced from the various species of *Agave* found in the Republic. A substitution of *maguey verde*, or some other good fibre producing agave for the *maguey blanco*, the pulque plant, would mean a tremendous increase to the national resources and at the same time do away with one of the greatest evils of the country. There is the same reason for destroying this plant wherever it exists in the country as there was for putting the ban on the opium poppy in China.

The vast areas in the state of San Luis Potosi and neighboring states now covered densely with cactus, both *Opuntia* and *Cereus* varieties, could be profitably cleared and planted to some fibre bearing agave. It is barely possible that the cactus thus cleared off might be put to some practical use. In the mean time there are hundreds of square miles already cleared and admirably suited to the growth of the maguey for fibre.

There are some sections poorly adapted to the cultivation of the more valuable crops where *Eucalyptus* timber will undoubtedly be a very rich investment. There are many Australian or Californian species which would do well under conditions of moderately large amounts of rain, such as *Eucalyptus globulus* and *Eu. corynocalyx*. On the other hand, the two species *Eu. rostrata* and *Eu. tereticornis* thrive very well with little moisture and would, therefore, be admirably adapted to growth in the Tehuantepec Isthmus territory where the rains are more infrequent than further north or further south. All of these varieties are succeeding well in Cuba and Porto Rico.

The value of eucalyptus is very great both for use as hardwood timber to replace mahogany and other similar woods, and also for use in railroad construction as ties and telegraph poles. As a hard wood, many species, notably *Eu. globulus*, take a very high and permanent polish and show a most beautiful grain. For use as railroad sleepers and ties the wood is quite unparalleled because of its resistance to rot. Although these species are known to possess these qualities in places where they have been tried, yet it must be a matter of experimentation in any new region. Possibly other species under other conditions may surpass these in value.

In many parts of Mexico there are grown very inferior grades of several of our temperate fruits. The production is not very great, but just enough to show that great results could be obtained by modern methods, since the trees can easily be acclimatized and all that is necessary now is proper management both of tree and soil. *Duraznos* (peaches) may be purchased at almost any market in season, but they are almost invariably hard, small, and more or less tasteless. This condition, it is true, is due partially to ignorance in picking, since they are seldom allowed to even approach maturity on the tree, but even beyond this the quality may be greatly improved by introducing and acclimatizing bud-wood from better varieties, and growing nursery stock for distribution in the various belts. Imported nursery stock of these, as of any other fruit trees, could hardly be expected to compete with home grown stock. In the southern portion of the state of Oaxaca, in the Oaxaca valley and also near Tomellin further north, conditions are most admirably suited to extensive deciduous farming; in may other localities, also, as in the Toluca Valley near Mexico City, may parts of the State of Jalisco, and other places.

The great value in peach culture, or in deciduous fruit culture in general, is attested by the tremendous retail price commanded by imported deciduous fruit in any of the large cities. In Mexico City or Vera Cruz a very common price to pay for improved peaches, imported, is from thirty-five to fifty cents (gold) per pound. Pears, apricots, plums and all the other temperate deciduous fruits, when imported, command a ridiculously high price. There is absolutely no reason why these improved varieties may not be grown in many parts of Mexico and thereby place on the local markets fruit fully equal in all respects to the California fruit and at the same time at a very reasonable price.

The adaptation of many parts of Mexico to temperate fruit culture is beyond dispute. As has been pointed out the topographical and climatic conditions vary more widely than in any other country in the world. The mild and even climate

of some parts without the excessive heat, with unexcelled soil richness and plenty but not too much water makes conditions in these regions fully as conducive to the production of first class deciduous fruit as does any part of California.

The apple is considered purely a northern latitude fruit. There are sections in Mexico, however, which by their altitude, and cold climate at certain seasons of the year, should produce very nice apples, not equal, perhaps, to the fruit of the northern United States but a very good substitute. The ground for this belief is the fact that apples are now produced in considerable quantity in many of the higher localities. The great inferiority in quality is due largely to the lack of proper culture. Here, again, the trees are all seedlings and unimproved in any way. The introduction of seeds of the best known varieties, and their growth, acclimatization and selection in scientifically conducted nurseries would soon place at the disposal of the people varieties not greatly inferior to those now bearing in Oregon. We are safely within reason, too, when we declare that other northern fruits, as the cherry for instance, may be grown in these same belts of the upper *tierra templada* or the lower *tierra fria*.

Another great field which soon must be opened to the agriculturist of Mexico is viticulture. There are just enough grapes produced now in some sections to show that it is possible. Here, again, the process of finding the best paying varieties, or even creating new ones, must precede the wide introduction of the industry. It has been found in other countries that certain native wild grapes can be used as grafting stocks. Whether this may be possible or not in Mexico, still there is plenty of acclimatized stock now growing in various parts which could be used as the basis for experimentation. In addition to finding the best varieties the horticulturist must also adapt the fruiting season to the climatic conditions. Since grapes are very easily ruined by excess of atmospheric moisture at the ripening period, it will be necessary to shift the fruiting season to come after or before the summer rainy period. As was pointed out in a previous paper, the Cuernavaca and Toluca valleys are very well adapted to the culture of the vine and in addition possess the unparalleled opportunity of a tremendous market for all their produce within a few hours by railroad.

Before leaving these special considerations of individual crops, let us take up one other. There are many sections too dry and barren at certain seasons of the year to be productive in other crops, but trials with the olive tree would surely be worth while. Certain portions of Oaxaca are well suited to the growth of the olive tree, and, in fact, the director of that state station is already planning to make a thorough trial under various conditions. The high price commanded by this product in most markets of the world, the great food value, and the ease with which the fruit is preserved and shipped makes olive culture extremely profitable in sections which are not well suited to many other crops.

This hasty survey is only presented as a stimulus to the thought as to what may and surely must be accomplished in the near future in Mexico. Only the bare outline of methods have been suggested and only a few of the typical localities mentioned, but enough to show the wonderful possibilities which are only waiting to be developed.

It is alluring to think of these possibilities, but the realization of them must come through hard and persistent effort and even financial losses by the way. There are three methods by which this advancement must be brought about in Mexico, as in all other countries. A basic knowledge of all scientific facts relating to the subject in hand is, of course, presupposed and absolutely necessary in all cases. A few trained men must be the teachers of the public. The first of the three methods is by means of the government experimental station, the second by demonstration farms operated either by the government or by private capital, and the third is by private farms operated for financial gain but at the same time by the most approved methods and working toward the selection of the best crops.

A beginning has already been made by the government on the first method. A central station at Mexico City with four state stations embraces the entire work in this direction. Three of the five stations were visited by the writer during the summer of 1910 and all the work reviewed with the greatest of interest. The work is new as yet and there has not been time to accomplish a great deal. Without criticizing any individuals connected with the stations, it might be said that more extensive and intensive work is necessary. The most up-to-date and improved methods must be tried out on the experimental farms before the people can be expected to adopt them. The station is supposed to be maintained at the highest standard of efficiency possible, but always doing practical and applicable work, and not necessarily paying its running expenses, but entirely maintained by the government. The efficiency of the station will depend solely on the amount of money allowed for its necessary expenditure and just as much, or *more*, on the man at its head. If, after a thorough investigation, a Mexican scientist proves to be the best, then he is the man for the place; but if a German, or a Frenchman, or an American shows himself to be the best man, then no national or race feeling of any sort should stand in the way of his appointment to the work in question. The government work in the United States has been carried on by men of many nationalities and the only thing that has ever been questioned is their technical and practical fitness for the work in hand—neither their nationality nor their religion enters into consideration. Brazil employs Germans, Swiss and Americans; Peru has engaged Belgians, and so on through nearly all the countries, expert fitness is becoming the only necessary qualification.

The work of the experimental station should be directed first toward the testing of varieties and methods of culture. New crops which might well prove of value should be given a thorough and extended trial. Improvement of nursery stock, methods of breeding, and determinations as to which of many varieties of a certain group of trees or plants are the most profitable; this must all be the work of the station staff, since none others in the country are in a position to carry on such work. Pest investigations and control must be directed by the station chief or one of his associates. For this work a thorough knowledge of entomology in all its branches is necessary, as well as a knowledge of fungous diseases and their treatment. This work should be carried on by the best of experts regardless of cost. The sugar planters of Hawaii and also in Porto Rico employ chemists, agriculturists, entomologists, and plant pathologists at a very great expense, whose

sole and only work is the study of insect and fungous pest control, and other pertinent problems, and they all say most emphatically that it pays.

One man on the staff must have a thorough knowledge of horticulture in all its bearings—plant-breeding, selection, culture and soil tillage, and fertilization. Another man should have a thorough and complete knowledge of soil and plant chemistry. *These men must be had!* If the youth of Mexico can be educated to a practical knowledge of these subjects so much the better, for local conditions are more thoroughly understood by them. In the mean time the world's best experts must be employed.

The demonstration farms may or may not be operated in connection with the experimental stations, but in either case they can easily be made to pay their running expenses, if not become more or less remunerative. The superintendent of each of these farms should have a thorough working knowledge of all the general phases of scientific agriculture and should put this knowledge into daily practice. The field of work must be supplementary to and following up the work of the station, and under the direction of the nearest station director. Results, methods and anything else worked out at the stations must be taken up at the demonstration farms on a large and paying scale in order that the public may be shown beyond question the value of the new methods, or crops.

The third method named is a direct appeal to the private farmer, whatever his nationality. One of the secrets in the rapid advance of American agriculture as it is carried on by the average farmer, is the fact that the farming population in nearly all localities is most cosmopolitan. Thus, ideas from all countries and from all sorts of minds are brought together and the best, or a combination of the best, takes precedence over the rest. Such a farm as that at Roma, Vera Cruz, which was mentioned above, will do as much for the advancement of the nation's welfare through its agriculture as almost anything else which could be attempted. The appeal now is for adoption of approved scientific farming by those now engaged privately in Mexico and, also, for others, of any country whatever, to take up practical, sensible scientific farming in some part of the Republic, and demonstrate to all the doubters the real value of such a course and the great folly of following any but the most up-to-date methods.

For the private farmer who wishes to make his living in agriculture, for the capitalist who wishes to invest in a safe and paying proposition, for the expert scientist—entomologist, mycologist, horticulturist, pomologist, agronomist—what more inviting field for labor will be found than in Mexico, with all its wonderful possibilities now beginning to unfold?

By opening its doors to applied science and improving the almost unimaginable possibilities thereby, Mexico could become one of the leading agricultural centers of the world. To bring this about will require the closest co-operation between people and government in all respects. The time when this condition will arrive will be determined by the readiness with which the government takes the initiative in founding many more, and better equipped, experimental stations and introducing horticulturists and other technically and practically trained men into the staff of these stations. With adequate demonstration of work in progress, we may rest assured that the private farmer will not hesitate to follow up the opportunities thus opened to him.

An Account of the Botany of the Brazil Nut*

W. J. YOUNG

ASSISTANT, MICROCHEMICAL LABORATORY, U. S. DEPARTMENT OF AGRICULTURE

The genus *Bertholletia,* to which is assigned the Brazil nut of commerce, was established in 1808 by Humboldt and Bonpland who placed it in a single species, *B. excelsa.* A translation of Bonpland's description of the fruit of this species follows.

"Fruit a spherical, compound nut the size of a child's head and often larger, divided internally into four cells each of which encloses several nuts; covered on its exterior with a husk of a green color, smooth and shining.

"Main nut very solid, rough and marked by branching furrows on its outer surface, 6 lines (1 cm.) thick, divided internally into four cells by as many membranous dissepiments which become obliterated in part or entirely after the maturity of the fruit, but of which there always remain traces."

The tree is described as 33 m. high with a trunk 9 dm. in diameter. Leaves alternate, oblong, subcoriaceous, 1 dm. broad and 6 dm. long, borne on short petioles. Type locality, Rio Orinoco.

On account of the great height of the trees these botanists were unable to obtain the blossoms although it is said that they offered in vain an ounce of gold for specimens. On this account they were uncertain as to the position which the genus *Bertholletia* should occupy in the vegetable kingdom. More recent investigations have established its position next to *Lecythis* in the order Lecythidaceae, an arrangement now universally accepted. It is worthy of note also that Bonpland failed to describe either the operculum or the opercular opening of the fruit although the latter is shown in his drawing as becoming decidedly narrower at the inner edge.

The two species of *Bertholletia:*—For more than half a century after the publication of Bonpland's description of *Bertholletia,* the genus was accepted as monotypic. Evidence was being gradually accumulated, however, which was destined to lead to the recognition of a second species. Among the later botanists to contribute to this end may be mentioned Berg who, in monographing the Brazilian Lecythidaceae described under the name *B. excelsa* a species distinct from the one so named by Humboldt and Bonpland. Although Berg's description is marred by several errors, it is sufficiently accurate to demonstrate that the species described is not the *B. excelsa* of Bonpland. Berg's drawing of the fruit or pyxidium is, moreover, quite different from that of Bonpland.

It remained, however, for Mr. J. Miers to point out clearly the distinction between the two plants and to describe Berg's species under the name *B. nobilis.*

The more noticeable points of distinction between *B. excelsa* and *B. nobilis* are collected from Miers' description in the following summary:

*Published by permission of the Secretary of Agriculture.

B. excelsa Humb. and Bonp.	*B. nobilis* Miers.
Tree 100 ft. or more high with trunk 2½ to 3 ft. in diameter.	Tree somewhat taller than *B. excelsa* with trunk 14 ft. in diameter.
Leaves green; petioles 9 to 18 lines long.	Leaves rufescent; petioles 3 to 6 lines long.
Floral panicle 8 in. long with single branch nearly equal in length and nodes 1-6 in. apart.	Floral panicle 10 in. long with about 5 short branches and nodes ¼ to ½ in. apart.
Fruit slightly elongated, 6 in. in length.	Fruit approximately spherical, usually under 5 in. in length.
Cortex of fruit smooth, polished, entire, persistent.	Cortex of fruit comparatively thick and rough, darker, contracting and cracking as the fruit dries and tending to loosen and drop off as the fruit is handled.
Opercular opening with straight or concave walls, narrowing slightly at its inner edge.	Opercular opening has sharp edge and concave walls, and widens considerably inwards.
Operculum cylindrical with roundish, indented apex.	Operculum oval or radially compressed, conical and pointed at the apex.
Operculum breaks away and falls from the fruit as the columella shrivels.	Operculum remains attached to remnant of columella and as the latter shrivels, falls into the cavity of the fruit.

The differences noted above, as far as they relate to the fruit, are well shown in the copy of Miers' drawing, reproduced half size in the accompanying Figure 46.

The source of commercial Brazil nuts:—The idea that *B. excelsa* Humb. and Bonp. is the source of commercial Brazil nuts has become so thoroughly grounded in popular and even in botanical literature that it seems to be accepted on faith and passes unchallenged. The extent of this belief will be apparent when we consider that of the following quotations only the last two, or possibly three, make any mention of a second species to which, moreover, they assign a wholly subordinate position.

"Brazil nut. One of the triangular edible seeds of a tall South American tree (*Bertholletia excelsa*) . . ."—Standard Twentieth Century Dictionary.

"Brazil nut. The seed of the fruit of *Bertholletia excelsa* . . ."—Century Dictionary.

"Brazil nut, an oily 3-angled nut, the seed of the lecythidaceous Brazilian tree, *Bertholletia excelsa*."—Webster's New International Dictionary.

"Cream nut (*Bertholletia excelsa* Humb. and Bonp.) This is a common nut in our markets brought from Brazil; hence it is often called Brazil nut."—Nut Culture in U. S., p. 106, Div. of Pomology, U. S. D. A.

"Brazil nuts, Cream nuts, Para nuts—These are edible nuts imported from Brazil—The nuts are the product of *Bertholletia excelsa* (Humboldt and Bonpland) . . ."—U. S. Disp. 19th Ed. p. 1420.

"*Bertholletia excelsa.* Brazil nut.

"A large tree belonging to the family Lecythidaceae, and yielding the Brazil or Para nuts of commerce. A tree 100 to 150 ft. high, distributed throughout

north-eastern South America to the Island of Trinidad."—Cook and Collins, Economic Plants of Porto Rico, Contrib. U. S. Nat. Herb. 8, 2 p. 91, 1903.

"*Bertholletia* Humb. and Bonp.—Tall trees. One or two species South America.

"*a. B. excelsa* Humb. and Bonp.—*Seeds*, Brazil nuts, Para nuts, Cream nuts, Nigger toes, Castana nuts . . ."—Lyons, A. B., Plant Names, Scientific and Popular, 2d Ed. p. 71.

"*Bertholletia*—Brazil nut, Para nut, Cream nut, Nigger toe—Species 2, both of which furnish Brazil nuts . . ."—Hastings, G. T., in Bailey's Cyc. of Hort.

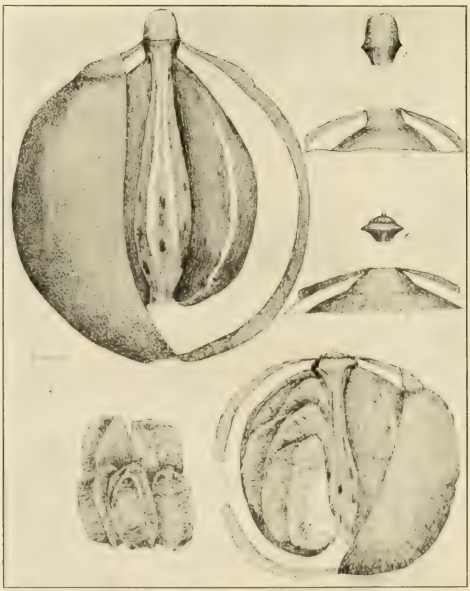


Figure 46. Reproduction of Mr. J. Miers drawings of Bertholletia, copied half size from Trans. Linn. Soc. XXX Pl. 37. Figs. 1-3, B. excelsa. Fig. 1, Pyxidium cut open to show structure. Fig. 2, Section of opercular opening. Fig. 3, Operculum. Figs. 4-7, B. nobilis. Fig. 4, Pyxidium cut open to show structure. Fig. 5, Section of opercular opening. Fig. 6, Operculum. Fig. 7, Nuts. Published with the consent of the Lumaean Society of London.

"The Brazil nut, also called Para nut from the port of shipment—is the seed of a large tree (*Bertholletia excelsa* Humb. and Bpl.)—Another species, *B. nobilis* Miers, also yields a similar nut." Winton, A. L. Micro. of Veg. Foods, p. 312.

This state of affairs seems to be due primarily to Bonpland's assumption stated in connection with his description of *B. excelsa*, that it is this species which furnishes the Brazil nut. The long time which elapsed previous to the identification of a second species allowed this view to become so thoroughly established that Miers' work appears to have been overlooked by persons interested in botany from the economic standpoint. The work of various botanists during this interval, and especially Berg's description of *B. nobilis* under the name *B. excelsa*, no doubt contributed to the same end. Moreover the seeds of the two species, so far as can be judged from the descriptions and drawings available, are so similar as to be distinguished with difficulty if at all.

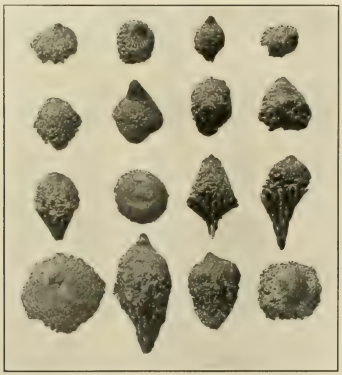


Figure 47. Opercula from commercial Brazil nuts. The pointed apex is broken from the operculum in the lower left-hand corner of the figure and is worn down to a certain extent by friction in some of the others (x2-3).

After making a careful study of the situation, the writer has become convinced that the commonly accepted view is erroneous and that the Brazil nuts of commerce are derived from *B. nobilis* Miers (*B. excelsa* Berg) and not from *B. excelsa* Humb. and Bonp. The reasons for this view are given below:

(a) Commercial samples of Brazil nuts contain, in larger or smaller numbers, opercula (Fig. 47) derived from the fruit and the presence of these in itself is evidence that the nuts were derived from *B. nobilis*, since, as has been noted in the comparison, the opercula fall from the mature pyxidia of *B. excelsa* and hence

would not find their way into samples of nuts from that source. On the other hand their presence among nuts from *B. nobilis* is perfectly normal and what would be expected since in this species the opercula fall into the interior of the pyxidia and become mixed with the nuts. Moreover, the opercula, so far as the writer has been able to observe, are always of the *B. nobilis* type, as shown in the figure. They vary in form from ovoidal bodies to cones of varying slope, being modified apparently by the size and degree of persistence of the columella as well as by the extent of the grinding against surrounding nuts to which they have been subjected during shipment. All, however, are provided with a distinct apical point except where it has been broken off, in which case the fact is usually quite evident. It cannot be denied that the absence of opercula of the *B. excelsa* type

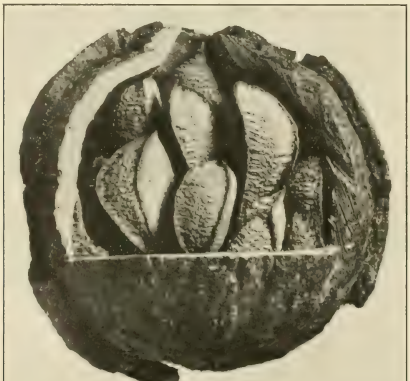


Figure 48. Pyxidium of Brazil nut cut open to show structure, with nuts in place. Note the pointed operculum, and the opercular opening becoming very broad toward the interior of the pyxidium. Small specimen, natural size.

does not preclude the possibility that nuts of this species may be occasionally mixed with those of *B. nobilis*, since the writer is not aware that it is possible to distinguish the species from the character of the nuts alone.

(b) Every pyxidium of the Brazil nut which the writer has had an opportunity to examine has indicated that the fruit is that of *B. nobilis*. Their main points of structure are well shown in the Figures 48 and 49 which illustrate pyxidia obtained from different sources. A comparison of the photographs with Miers' description of *B. nobilis* will leave no doubt of their identity. Most if not all of

the pyxidia which the writer has examined were brought to this country by the importers of Brazil nuts and represent the source of the nuts in which they deal.

(c) The testimony of others, although comparatively scanty, should not be overlooked, since it is improbable that the authorities quoted as stating that the Brazil nut is the seed of *B. excelsa* have given the matter any exhaustive study. After his description of *B. nobilis*, Miers states: "These seeds are known in commerce as Brazil nuts;" and proceeds to give statistics regarding their exportation and use. Moreover, Berg's error regarding *B. excelsa*, although perhaps adding to the confusion, is in reality indirect evidence of the same fact, since it is doubtful if he would have confused the two species had he not been sure that the specimens from which he made his description were those of the Brazil nut which he, in common with others of his time, regarded as *B. excelsa*.

Figure 49. Pyxidia of Brazil nuts from various commercial sources showing characters which identify them with Bertholletia nobilis Miers (x3/4).

Figure 50. Showing the disastrous effect of mixed planting on what was formerly a magnificent avenue. The three trees to the left are Poinciana regia, the two recently planted on the right are Albizzia lebbek, while back of these is one large evergreen, Ficus nitida. Beyond stretches a fine solid avenue of leguminous trees.

Some Aspects of Avenue Planting

C. F. BAKER
POMONA COLLEGE, CLAREMONT, CALIFORNIA

In the growth of civilized communities, especially those most attractive for residence purposes, the matter of highways early becomes one of fundamental importance. As the community develops, the idea of an *avenue* is evolved—a roadway that shall be a thing of beauty, a joy and comfort to the traveler, and an ever-present satisfaction to the dwellers along its path. The high value of a perfect avenue as a real asset to any district, is now everywhere recognized. Property along a well kept avenue is invariably augmented in value thereby. Towns are always more desirable as places of residence, where the streets are developed on a well-thought-out and unified avenue plan.

Where avenue development is extended to country roads, a rural district may easily be peculiarly distinguished thereby, and become especially attractive for rural residence. In most parts of the United States, this important work is either entirely neglected or only just beginning. In Cuba, under Spanish dominion, a system of grand country avenues radiating from Havana was splendidly developed by the Spanish engineers. These engineers evidently possessed a very

clear idea of the two fundamental principles of permanent avenue building: 1, the establishment of a solid roadbed, and 2, suitable uniform and permanent border plantings of trees. These roadbeds are built on well made foundations of crushed stone, and once in their finished form, are kept constantly in perfect order by section crews, just as our railways are worked. In sharp contrast to such a method is ours of neglecting a well-built avenue until it is in such bad condition that

Figure. 51. A Cuban country avenue in winter. Note the large dark pods of Enterolobium and the long slender pods of Pithecolobium saman. In this case a fine uniformity of result is obtained even with a mixture, on account of the striking resemblance in form and habit of the two trees employed.

Figure 52. An avenue of peppers (Schinus molle) in Pasadena. No plantings can exceed in charm a well matured pepper avenue.

Figure 53. An avenue of Cedrus deodora in Altadena. This is a tree most unsuitable for avenue plantings in any country, but trebly so in a hot one.

it must practically be made over again at great expense of money and patience, and we frequently plant and replant without any comprehensive plan to follow when the time element is really of far greater moment than the expense involved.

The chief element of beauty—and of utility in the warm countries—lies in the border plantings of the avenue. It may be accepted as a foundation principle that the finest effects are to be obtained only by absolute uniformity in the plantings. Some of the later work on the Cuban country avenues has paved the way for utter destruction of some of the magnificent effects formerly produced there. This is resulting from a mixing of the plantings. Their finest avenues dating from former days are planted with *Enterolobium cyclocarpum*, *Pithecolobium saman*, and *Ficus nitida*, a portion of the Guines calzada planted with the last

Figure 54. Alternating Camphor and Chamaerops excelsa in Pasadena. A poor combination from any point of view. The palms cannot be permanent under the rapidly extending camphors, and merely interfere with their growth, besides destroying the fine effect always resulting from uniformity.

named tree giving one of the most magnificent avenue effects known to me in the two Americas. Unfortunately no attempt is made apparently to keep these plantings uniform, open spaces being filled indiscriminately with *Ficus religiosa*, *Albizzia lebbek*, *Poinciana regia*, and various other things, none of them so well adapted for avenue planting in Cuba as are the first three mentioned.

Ideal avenue plantings for warm countries should employ trees with broadly spreading tops which will shade the roadway, at least in the hottest season, and still permit open views to the surrounding country. In warm countries with wet

Figure 55. An avenue of Washingtonia robusta on the Huntington estate at Oak Knoll. One can almost feel the quiver of the heat down this hot, dry avenue of widely placed desert palms.

Figure 56. An avenue of Cocos plumosa on the Huntington estate at Oak Knoll. These palms give an effect of great delicacy but should never be used except for short distances.

winters a deciduous tree is often preferable. Palms are monotonous, and for this and other reasons most unsuitable for long avenues, though for short distances they sometimes make magnificent displays. Slender and spire shaped trees are very ill-adapted for this purpose in warm countries. Nothing can exceed the beauty of a well developed and well kept pepper drive, and this tree, together with camphor, *Eucalyptus viminalis* and *E. corynocalyx*, give splendid results in dry, warm countries. There are still others even finer than these which we as yet know but little and which are destined to add much to the beauty and interest of our avenues, as has frequently been indicated by Dr. Franceschi. We are trusting he will describe and illustrate these for us in future numbers of this Journal.

In the meantime several working principles may be brought sharply to the attention of all property owners of Southern California and other subtropical regions:

1. Plant *now!* A month or a year saved now means a matured avenue growth so much the sooner.

2. Place this work under the strict control of county, town, or park officials, and then urge them to immediate action. Left to the whim of individual property owners, uniformity of plan will certainly be impossible to attain, to the great and long-time detriment of the whole locality. Private individuals should no more be

Figure 57. Showing use of Phoenix canariensis as an avenue tree. After the many years required for full development this short stretch of solid Phoenix will be of great magnificence.

allowed to plant without permission and oversight, than they are allowed to cut down street trees without permission—and either is a fatal error.

3. Trees once planted should receive constant care throughout their lives. This is invariably the price of a perfect avenue. Watering and pruning, when not attended to by property owners, should be arranged for by the proper officials, and the costs levied against the property. This would be only right and just since the existence of a perfect avenue adds very materially to the value of all adjoining property, and the failure of one owner may not only spoil the effect of the whole but in this way actually detract from the value of surrounding property.

The Development of the Avocado Industry

F. W. POPENOE, ALTADENA, CALIFORNIA

Within the past twelve months interest in growing the avocado has increased many fold. The feeling has now become general among well-informed orchardists and nurserymen that this fruit is destined to play an important part in the economic horticulture of Southern California; and many wise growers already foresee great promise for this new industry. The adaptability of the avocado to out climatic conditions has become convincingly apparent, and belief is growing into conviction that it is to rival the orange as a semi-tropic product. As a future food product it is unquestionably an important factor to be reckoned with. Economists who have the ability to grasp matters horticultural are figuring the avocado into the future food supply of the country at large as a competitor of meat, and are estimating its possibilities for replacing animal products with a wholesome and delicious vegetable food. As eminent and practical a horticulturist as Mr. Parker Earle, formerly president of the American Pomological society, is convinced of an immense future for the avocado. In a recent letter to the editor of the Pacific Garden, Mr. Earle says: "We cannot help wondering, as we look ahead for a hundred years, how people will live—what they will eat—when there are four hundred millions to be fed out of the land that now supports one hundred millions. With this great density of population, will there be room for producing much animal food in that time? Will it not become a necessity of existence to utilize all of the land in a way that will yield the greatest tonnage of human food?

"An acre of land can produce, let us say, one quarter of a ton of beef, or other animal food, per year. It can produce one ton, or possibly two tons, of food in wheat, or corn, or rice. It can produce five, ten, or possibly twenty tons of an incomplete food ration in the form of apples, or grapes, or bananas. And there may be from one to two tons or more of very rich food in the form of nuts—notably pecans—from one acre of land. But with avocados there would seem to be a possible yield of food of very high nutritive value in tonnage equal to apples with their low nutritive value." Mr. Earle goes on to state that if men can produce many tons of food of best value from an acre of land in trees that can only yield a fraction of a ton in the form of animal food, it is pretty certain that they are going to plant trees. The crowding of men together in dense population will compel this. "In primitive conditions men turned to animals for food. It was a state of savagery. We are outgrowing it. Very soon there will be no room for animals that are grown to be eaten. It is compulsory. It is nature's way. We must get our food in greatest quantities from a minimum area of land. And we must have food containing the same elements that animals have been giving us. Among these substitutes does not the avocado offer itself as one of large possible importance?"

The one answer that can be made to Mr. Earle's inquiry is—it does.

Progress in Florida

Along both the lines of propagation and commercial planting Florida has so far been in the lead of California. The proximity of Cuba, where the avocado, or aguacate as it is called in all Spanish speaking countries, is commonly grown, and the fact that seedlings had been planted quite freely along the east coast in the earlier days, must have led horticulturists there to see the possibilities of this fruit, and have acted as a stimulus to the development of the industry. When, in 1901, it was successfully demonstrated that the avocado could be propagated by budding, considerable attention was at once directed to this fruit as a commercial possibility, and since then the progress of the industry has been steady.

Figure 58. Young avocado trees growing in nursery rows at Altadena, California, one year old and ready for budding.

One of the most important of the earlier commercial plantations, and in fact the first plantation of any extent, was that of Mr. S. B. Bliss of Miami. His orchard consists of twenty acres of the Trapp variety, planted six years ago, and now in bearing. The first crop of marketable fruit was produced last year, and though a heavy yield could not be expected from trees so young, the returns were satisfactory. Mr. Bliss is an experienced and careful grower, and has given intelligent consideration to the avocado as a commercial proposition both in Florida and in Southern California, and has great confidence in its extensive development.

Having had many years experience in both localities Mr. Bliss is well qualified to speak on the subject.

More recent than Mr. Bliss' plantation, considerably larger acreages of the avocado have been planted on the east coast, and planting is going on as rapidly as the budded trees can be supplied. As a considerable quantity of the fruit is now produced each year and shipped to northern markets, the Florida growers have learned a number of things regarding packing and shipping which will be of value to Californians.

Figure 59. A two year old head of the Trapp variety, top worked on an old seedling tree, at Sherman, California.

Mr. Joseph L. Hickson, of Miami, who grows the avocado extensively, writes under date of July 5, 1911, as follows: "We have never been able to supply our demands except for the varieties that mature in mid season (last half of August and first half of September). We are therefore growing and propagating more early and late varieties, Family and Trapp, respectively.

Figure 60. A fine type from Cuernavaca, Mexico. A thick skinned, purple, winter bearer.

"We have customers who place season orders with us for all the fruit we have at $6 per case, f. o. b. Miami, which price we are very well satisfied with.

"We pack according to size, sometimes only 18 fruits to the case, but usually 36, 45 or 48. Our fruit went to all the eastern markets and to Chicago and Cincinnati.

"The propagation of the avocado is done exclusively by budding now, with a success equal to 95 per cent.

Figure 61. One of the first avocados planted in California, being one of three trees brought from Mexico and planted at Santa Barbara by the late Judge Ord in 1870. (Photo from Dr. Franceschi).

"This section of the state is extending its planting very considerably. Personally we believe there is more money to be made on the finer varieties of avocado and mango than there is with either oranges or grapefruit. The avocado does not require nearly so much care and attention, and so far is practically free from all insect pests, nor does it require the amount of fertilizer that a citrus tree does.

"The budded trees come into bearing the second or third year from the bud and in heavy bearing the fourth year. The budded trees show a tendency to be dwarfed."

From Mr. E. N. Reasoner, of the Royal Palm Nurseries, Oneco, I have the following under date of June 30, 1911: "The avocado is being planted extensively

Figure 62. A thick skinned summer bearing type from Guadalajara, weighing about 14 ounces each.

by numerous people in both small and large lots; one man has 100 acres practically all to the Trapp variety, in fact the planting is more of this variety than of all others combined. There is a fine grove of 40 acres of Trapp, and two others of nearly 100 acres each, mixed avocados and mangos, of which the avocados are nearly all Trapp. The next important variety is Pollock.

"Budding is very successful, and a large percentage take. The buds are usually put in in spring, on trees of the preceding year's growth.

"Trees are being set about 18 or 20 feet apart. The trees are looking well and interest is high. The trees of sufficient age have a large crop of fruit this season."

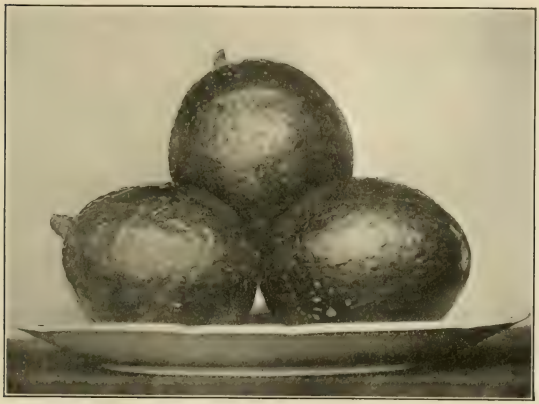


Figure 63. A desirable type grown in Mexico at an altitude of 6000 feet. A winter bearing, very thick skinned fruit of fine quality. It is now being propagated in California.

Mr. John B. Beach, of West Palm Beach, who propagates the avocado quite extensively, writes as follows under date of July 1, 1911: "After November first there is always a good demand in New York for avocados, with ever increasing prices as the season advances, and often they sell well in October. Owing to its lateness we prefer the Trapp for general market planting, though there are many other varieties which are being tested, but have not been cultivated long enough to be well known.

"Budding is most successful in late autumn and winter, from November 1 to April 1. Fifty to ninety per cent of the buds will 'take,' but more or less loss

will occur after that from eyes dropping off, and from fungus attacking young sprouts. This trouble may not be so bad with you. Very likely the beginning of your dry season will be the best time for budding on this account. Our rainy season is in summer, and then we suffer most from fungus.

"Budding is most simple. Use well developed eyes on young wood, the bigger the shoot the better provided it is of last growth, otherwise you will have trouble with buds failing to start, and eyes dropping. We start the seeds in six inch pots, budding and removing at the same time into 6x6x12-inch shingle boxes, at five to seven months from the seed. Allow six months in these boxes for the buds to grow, then plant out."

California Plantings

The production of varieties suitable for commercial purposes here has so far been dependent upon chance seedlings, no systematic attempt to breed superior varieties having been made. The variation always exhibited by seedlings has resulted in the existence of numerous forms and types, a few superior to the average, but by far the greatest number inferior to or no better than the average. Realizing, however, the possibility of obtaining choice varieties by chance in this way, and varieties which would be especially well adapted to this climate, several experimental plantings have been made.

One of the largest of these is that of Mr. William A. Spinks, of Monrovia, who has obtained selected seeds from every available source and set out 150 seedling trees in orchard form. (See also the reference made below to his orchard planting of budded trees). Mr. Spinks' location is one of the most favorable in Southern California, and with this number of selected seedlings the possibility of obtaining something choice is certainly good.

Mr. Joseph Sexton, of Goleta, near Santa Barbara, has planted 140 seedlings, 100 of which were grown from selected Hawaiian seed and the balance from selected seeds from Mexico, Costa Rica, Guatemala, and Porto Rico. In addition to this plantation of his own, Mr. Sexton is planting for other parties in his vicinity over 600 Hawaiian seedlings, of his own raising, all of which will be allowed to grow as seedlings until they have had time to fruit. This extensive plantation of Hawaiian seedlings will form an admirable test of this type of avocado, and as the climate of Santa Barbara is notably mild, the possibilities of success are good.

These plantations have only recently been made and will require some time before the results will be known. Older than either of the foregoing is that of Mr. C. P. Taft, the well known horticulturist at Orange, whose work along various lines of experimental horticulture has been of great value to the state. Mr. Taft began planting avocados in a very small way seven or eight years ago. His orchard now consists of several acres of seedlings, may of which are producing fruit. So far Mr. Taft feels that he has not produced the ideal avocado, and is continuing his experimental work by selection of his most desirable seedlings rather than by securing buds from other countries.

Mr. E. S. Thacher of Nordhoff, another of the well informed and experienced horticulturists of Southern California, has been interested in the avocado for

Figure 64. A cluster of Hawaiian avocados, showing the typical Hawaiian fruit. Each of these fruits weighs from 15-24 ozs.

several years and now has a plantation of 120 seedlings just coming into bearing. Among those which are fruiting this year Mr. Thacher has one tree that at the time this is written, and before the fruits have matured, bears promise of being especially worthy of propagation.

Because of the impossibility of obtaining budded trees in sufficient quantity for orchard plantings, almost no plantations of budded trees have been made in Southern California up to the present time. Several parties, however, have made plantations of seedlings with the intention of budding the young trees to some desirable variety, and in this way saving considerable time. Probably the largest of these plantations is that of Mr. W. G. Davison, at La Habra. Mr. Davison has twenty acres set to Mexican seedlings and is now budding them to choice Mexican varieties.

Mr. William A. Spinks of Monrovia has a plantation of about 600 budded trees of various varieties, which is more in the way of an experimental planting, perhaps, than a commercial orchard. A few other plantings of seedlings have been made, with the intention of budding the trees as soon as it is possible to obtain budwood of choice varieties, but the majority of parties interested in the commercial production of avocados are waiting until they can obtain budded trees with which to make their plantings. Another year will see the work of planting orchards well under way, as the growing of budded stock is being given adequate attention. Among those engaged in this branch of the industry, the West India Gardens, a tropical nursery company at Altadena, has many thousand young Mexican seedlings in the field which are being worked to the choicest Mexican varieties. This company sent its own representative to Mexico to locate the trees bearing the most desirable fruits. The trees selected were marked, and budwood from them is now being sent up. As in the selection of this stock all points of desirability were considered, a choice lot of budded trees will be the result—a result which by the process of growing seedlings at home and selecting therefrom, it would have taken many years to bring about.

Co-Operation of the Department of Agriculture

Realizing the possibilities of the avocado as a commercial proposition in Southern California, the United States Department of Agriculture has become interested in the development of the industry, and has recently sent out a large shipment of budded trees for trial. This shipment consisted of four sets of about eighty trees each, all budded, which were propagated at the Subtropical Laboratory of the Department at Miami, Florida. These four sets have been planted by co-operators in San Bernardino, Pasadena, Whittier and Altadena, so as to test them out under different climatic conditions. The set includes all of the standard Florida varieties, Trapp, Pollock, Mitchell, Baldwin, Family, Wester, Blackman and Peacock; one variety from the Bahamas called Largo, and unnamed varieties from Mexico, Guatemala, Cuba, California, Canary Islands, Florida and Hawaii. It is expected that when these trees come into bearing several choice varieties will be obtained, and it will also give an opportunity to thoroughly test out the Florida varieties under the different climatic conditions obtaining in Southern California.

The Commercial Avocado

At the present moment the question of greatest importance to prospective avocado growers is "What are the best varieties for commercial purposes?"

We have as yet no standard varieties, and it will be well, therefore, before the industry becomes established, to consider the characteristics required in an avocado for commercial purposes, and to obtain only those that come nearest to the ideal in every respect. It would be dangerous, to say the least, to rush into such an extensive industry as this promises to become, without having thoroughly considered this question and having obtained the very best to be had for our plantings. Eventually the better varieties would come to the front anyway, and loss of time and disappointment will be avoided by giving careful thought to this matter in the beginning.

1. Season

It is the hope of those interested in the development of the avocado industry in California that it will be possible to obtain for this climate a set of varieties that will provide fruit of good quality continuously throughout the twelve months of the year. And it seems as though this desire is to be realized in the near future, for already we have mature fruit from September to June inclusive, which leaves only a small gap to be filled in. But these varieties we already have do not come up to our requirements in most respects, so that they are only of value to demonstrate what can be done in the way of extending the season. It will be a notable thing to have avocados in the market every month of the year, and will tend to greatly increase the consumption of the fruit. And when the avocado comes to be known and valued as a food product, there will be a steady demand for it throughout the twelve months of the year. At present, however, there is the greatest demand during the winter months, when other fruits are scarce. The Florida growers have almost ceased to plant anything but winter bearing varieties, not because there is no demand for the fruit in summer, but because at that season many small avocados are thrown on the markets of the east from the West Indies, and this fruit sells at such a low price that it is not profitable to compete with it. However, the greatest demand has always been during the winter months, when the markets of the country are not filled with other fruits, and it will doubtless be advisable for California planters to follow the precedent of the Florida growers to a great extent and plant mainly of winter and early spring bearing sorts.

2. Hardiness

While there are doubtless limited areas in Southern California where avocados from the West Indies and Hawaii will thrive, our limited experience leads to the belief that for general culture in California we must have hardier varieties than those localities ordinarily produce. Avocados from the Mexican highlands have proved to be hardy almost anywhere in Southern California, and suited to as large an area as the orange. There are many locations in Mexico where avocados are produced in quantity, where fully as low temperatures are experienced as are ever felt here. Indeed, it is stated by G. N. Collins, a well known authority, that he found in one locality in Mexico avocados growing and thriving where snow fell

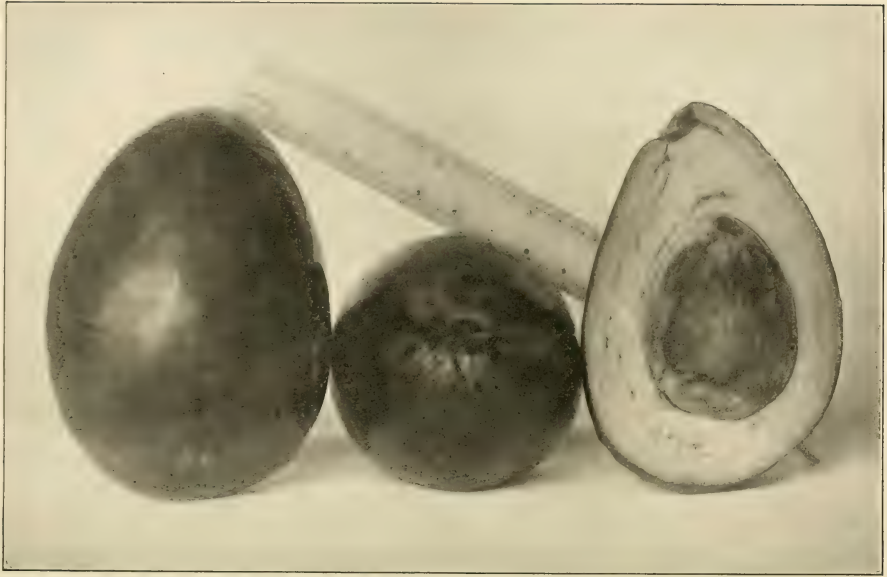


Figure 65. The common Mexican type of summer bearing, thin skinned, purple avocado.

every winter. If these hardier varieties were all small or inferior, we would of course prefer to take the chances with the more tender but superior ones, but there are many fine Mexican and Central American varieties which possess the requisite of hardiness in a very satisfactory degree.

3. Yield

Through propagation by budding a great difficulty experienced with the seedlings has been done away with, namely, the liability of the tree to bear sparsely or not at all. The orchardist does not, of course, want to plant a tree on which he cannot depend for a good crop. While the smaller types of avocados are almost invariably prolific bearers, the larger varieties when grown from seed are inclined to considerable variation in this respect. Through budding the prolific varieties may be propagated and all danger from this source done away with. The avocado is ordinarily a good bearer. It is not unusual for mature trees of the larger varieties to produce a crop of five hundred to one thousand fruits each season, and the small purple varieties are sometimes extraordinarily prolific, a single tree bearing as high as four thousand fruits in one season, in some instances. To make a variety profitable commercially it must, of course, be a fairly prolific bearer, and it should be ascertained to a certainty that this is the case before planting a tree.

4. Size

A mistaken idea which is held by many prospective avocado growers is that the larger the fruit the better. The experience of the Florida growers has proven conclusively that this is not the case when it comes to a question of marketing the fruit. A two or three-pound avocado is certainly a regal fruit, but will not prove half so profitable commercially as a smaller and consequently more prolific variety. From fifteen to twenty ounces would seem to be the most resirable size.

5. Form

It has been found very desirable for shipping to have fruits of oval or round form. The necked varieties necessitate considerable more care in packing, and are much more liable to injury in transit. For local consumption, however, a pear shaped or "bottle-necked" fruit is as good as any other form.

6. Uniformity

To facilitate packing, the product should be uniform in size as well as in form, and this also improves the appearance of the fruit as it lies in market.

7. Color

The attractiveness of a fruit is affected considerably by its color. Locally the purple varieties have sold somewhat more readily than the green ones, and in Florida the dark crimson ones seem to be favored. But when the people are thoroughly familiar with the avocado the color will probably make little difference, unless some particular color or shade is found to denote a particularly good fruit.

8. Skin

A skin sufficiently thick and tough to stand shipment to great distances is a prime essential. This is found in many of the Mexican varieties, and is partic-

ularly prominent in the Guatemalan type. Some varieties have a skin so thick and tough that it could almost be called a shell, while many of the Mexican varieties have a skin so thin and papery that the fruit when fully ripe will scarcely bear handling. A good tough skin will cut down the loss of fruit in transit to the minimum.

9. Flavor

As with all other fruits, there is considerable difference in the flavor and quality of avocados. This is, of course, a point which must be given first consideration, as a fruit of inferior quality would be undesirable in the extreme, even though it possessed all the other essential characteristics. Those containing the highest percentage of oil are naturally the most desirable from an economic standpoint, and having the highest percentage of fat they are ordinarily the finest flavored. Sometimes there will be found fibres or "strings," (fibro-vascular bundles) extending through the flesh from base to apex, and this is a very objectionable feature. It is, fortunately, rarely met with in the larger varieties.

10. Seed

The seed should be tight in the cavity. It has been found that in shipping loose seeded fruits, the seed in transit pounds the walls of its cavity and causes considerable injury to the flesh. This is a difficulty seldom met with in Mexican varieties, but often encountered in Florida. In size the seed should, of course, be as small as possible. In time a seedless variety will no doubt be developed, as has been done with the orange and other fruits.

Improvement of Citrus Stock Through Bud Selection

ROLAND S. VAILE
LIMONEIRA RANCH, SANTA PAULA, CALIFORNIA

It is the opinion of the majority of men engaged in the citrus business that because of the rapidly increasing acreage of citrus fruits in Southern California the average selling price is bound to reach a somewhat lower level within the next few years. In the case of lemons, at least, there is the added danger from a possible reduction of duty on the imported fruit. In order that the industry maintain its high rank from the standpoint of the investor and land holder this decrease must be met by greater efficiency in some phase of the organization.

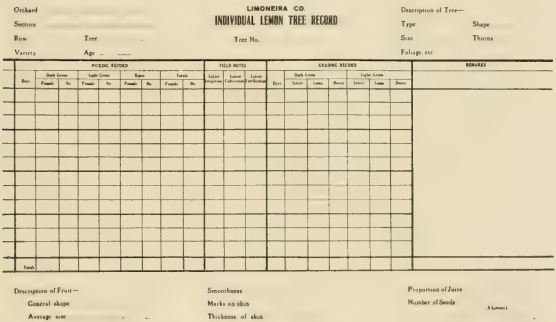

Orchard
Section
Row Tree
Variety Age
LIMONEIRA CO.
INDIVIDUAL LEMON TREE RECORD
Tree No.
Description of Tree—
Type Shape
Size Thorns
Foliage, etc
PICKING RECORD
FIELD NOTES
CRATING RECORD
REMARKS
Description of Fruit—
General shape
Average size
Smoothness
Marks on skin
Thickness of skin
Proportion of Juice
Number of Seeds

Figure 66. Reduced cut of blank used at the Limoneira Ranch for records of individual trees.

The California Citrus Union, with its wide advertising policy, its co-operative selling methods and its supply department, is already by far the most complete organization of its kind. Improved methods have reduced somewhat the cost of field and packing house operations. Careful handling has cut down the large losses through decay. While these matters will still permit of improvement and saving, one is led to wonder if the orchard itself can not be so intensely cultivated as to increase the average production. As one goes from orchard to orchard, or carefully through an individual grove, apparent differences are noted that show possibilities of materially raising the average standard.

A little less than two years ago Mr. A. D. Shamel of the Bureau of Plant Industry took up the work of gathering data which might lead to systematic bud selection for citrus stock improvement. The report of his first year's work was given at the State Fruit Grower's Convention held last March, and at that time a committee was appointed to consider the question of pedigreeing citrus trees. Mr. Shamel's work has been confined to oranges and grapefruit in the vicinity of Corona. A very full report of the first year's observations is given in his report to the Bureau of Plant Industry, published as circular No. 77.

About a year ago the Limoneira Company took up similar work on the Lisbon lemons in their grove, and later on Eureka lemons in the thirty-five year old orchard of Mr. N. W. Blanchard of Santa Paula. This work is being carried on because the company is planning large plantings in the near future and wish the best stock available from trees whose merits have been proven. Much of the data, however, is of interest to every nurseryman and orchardist.

In the first place the section of the orchard that has been consistently the best bearer for a number of years was chosen for the observations, and from the 2,000 trees in it the best 200 were picked. These trees were chosen for their apparent crop, the appearance of the fruit, the general form and foliage of the tree, and the absence of thorns. Later the number was reduced from 200 to 100, which were marked and numbered.

The next step was a description of the trees. The photograph method used by Mr. Shamel would undoubtedly have been better in many ways, but was not undertaken here. The written description included the size, shape, form, foliage, thorns and setting of fruit for each tree. With this preliminary work completed we were ready for the data of individual yields, the permanent record of which is kept in the form reproduced in the accompanying cut.

During the year the average yield per tree for the special trees was 13.45 field (45 lb.) boxes. The average for the rest of the section (all misses and extremely poor trees having been eliminated in the count) was 10.25 boxes, showing a difference of over 150 pounds to the tree. To the casual observer the trees in the section look very uniform, and yet this wide variation exists. If one-half of this difference could be overcome by raising the standard of the poorer trees the increase would be at least 100 packed boxes to every acre. Or on a percentage basis, an increase of about 3%.

To show that this work needs the accurate keeping of records, even the special trees varied from 15.4 boxes to 10.1, although the trees were chosen by experienced men who knew the groves.

The data from this first year's work is, of course, very preliminary. After these records have been kept for a number of years we will be able to tell whether the apparent differences are repeated. We will know whether certain trees are inherently summer bearers and others not. Then, too, we wish to determine whether the characteristics that may be proven for the parent tree will be transmitted to the offspring by budding, and in order to determine this the buds taken from each individual tree will be used in a definite block of the nursery, and later set in a definite part of the grove—records of which will be carefully kept.

In view of the large possibility of increase that this first year's records have shown, it is thought that others may want to adopt the same method, gradually becoming more and more familiar with good and bad types of trees, eliminating the latter, demanding more reliable data in regard to the source of nursery stock, and thus constantly raising the standard of citrus orchards in general.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume I DECEMBER 1911 Number 4

The Mango in Southern California

F. W. POPENOE
WEST INDIA GARDENS, ALTADENA, CALIFORNIA

The mango, with which but few people of California are intimately familiar, is throughout the tropics where extensively grown, the fruit of first importance. While systematic cultivation on an extensive scale has been applied to it in comparatively few countries, in all parts of the tropics it is grown in the greatest profusion and valued about as those of temperate climates value the apple. To those who are familiar with its finer varieties it is held in the highest esteem, but it is a regrettable fact that in many localities it is found only in inferior seedling forms, and this is accountable for the misunderstanding which exists in the minds of some Americans in regard to this fruit.

In India the cultivation of the mango extends back to the remotest antiquity, and careful selection of seedlings has resulted in the production of the finest varieties now existing. These have been propagated to a limited extent by inarching, and the Indian mangos are now famed as the finest mangos in the world.

The fruit has been termed "the king of tropical fruits," or "the apple of the tropics." Its beautiful coloring and delicious flavor, together with its extensive use in all tropical countries, seem to warrant these appellations. In many countries it is one of the commonest of fruits, growing in a semi-wild state, and forms an important part of the diet of the natives during the season when it is to be obtained.

According to DeCandolle, the mango is a native of South Asia and the Malay Archipelago, but it has long ago spread from its native home to the most remote corners of the earth. In Florida it is now attracting attention as a commercial proposition, and plantings of considerable extent are being made. Through the introduction of some of the choicer Indian varieties, many of which have already produced fruit, the mango industry in Florida has become one of great promise.

Until late years the slow and laborious method of inarching had to be resorted to for the perpetuation of any desirable variety, but recently several methods of budding have been successfully practiced and by these means the production of trees of known varieties on a commercial scale has been made possible.

The value and esteem in which the mango is held are attested by an article in a recent number of the National Geographic Magazine, by no less an authority

than Mr. David Fairchild, in charge of the Agricultural Explorations of the U. S. Department of Agriculture, himself a man of wide experience in tropical countries and familiar with the mango in its native home. He states: "The mango is one of the really great fruits of the world. India, with its hundreds of millions of people, has for centuries held it sacred, and celebrates annual ceremonies in its honor. The great Mogul Akbar, who reigned in the sixteenth century, planted the famous Lak Bag, an orchard of a hundred thousand mangos, and some of these still remain alive. It is a fruit the importance of which Americans are at last beginning to recognize, notwithstanding the unfortunate discredit which some of the worthless seedling mangos of Mexico and the West Indies have given it in the minds of Americans generally.

"There are probably more varieties of mangos than there are of peaches. I have heard of one collection of five hundred different sorts in India. There are exquisitely flavored varieties no larger than a plum, and there are delicious sorts the fruits of which are six pounds in weight. In India, where the wage of a coolie is not over 10 cents a day, there are varieties which sell for $6.60 a hundred and the commonest sorts bring over a cent apiece.

"The great mango trees of India are said to reach a height of seventy feet, and are so loaded down with fruit that over $150 worth has been sold from a single tree.

"These fine varieties, practically as free from fiber as a freestone peach, can be eaten with a spoon as easily as a canteloupe. Trainloads of these are shipped from the mango-growing centers of India and distributed in the densely peopled cities of that great semitropical empire; and yet, notwithstanding the great importance of this fruit, the agricultural study of it from the new standpoint has scarcely been begun. I believe that it has never, for example, been tested on any but its own roots."

The mango has received only the slightest attention in California, but its inherent value and the fact that it has been proven to be a possibility for parts of the state have seemed to warrant the preparation of this preliminary paper on the subject.

Its Present Status in California

So few mango trees have been planted in Southern California, and these have been of such a nondescript character, that no adequate trial can be said to have yet been made of this fruit. Not until superior forms are given a trial under a variety of conditions, and afforded every possible assistance to make them a success, will we definitely know what can be expected of the mango in this state; and yet the results with the few seedlings now in bearing have been so encouraging as to leave little room for doubt as to the future possibilities of this fruit in California.

In considering the behavior of, and results obtained from the trees which have fruited here it is important to take into consideration the fact that they have, almost without exception, been subjected to the most adverse conditions—conditions which would prove fatal in a year to the majority of our temperate fruits—and under these circumstances the behavior of some of these trees is truly re-

markable. Planted in poor soil in some instances and left to shift for themselves, getting no care whatever and no water except from the skies, how could they be expected to do their best? When subjected to such conditions it is little wonder that their growth has been stunted and unhealthy, and that many of them have failed to mature their fruit. The few trees which have had reasonable care

Figure 67. Seedling mango on old Miller place at Hollywood, California.

have done much better, and although they have shown that the growth of the tree will be much slower here than in tropical countries, and the large proportions attained by the mango further south will probably never be reached, yet good healthy growth has been made, fruit has been produced abundantly, and no diseases have appeared to affect the tree or fruit.

The cultivation of the mango in California probably dates back not more than thirty years. One of the earliest trees planted was that on the Jacob Miller place in Hollywood. The seed came from Guatemala City and the tree was set

out in its present location almost thirty years ago. This tree has had the advantage of a very mild location, which though not favorable to the rapid growth of the tree or the perfection of its fruit, has enabled it to develop into a good sized tree without being cut back by the frost. The fruit produced is of little value, but the enormous productivity of the tree is surprising, it frequently carrying over a thousand fruits in one crop. Few of the fruits reach a mature size, however, and none ripen perfectly.

Other trees planted more recently are now in bearing, and being situated in several different localities their behavior may be taken as giving something of an indication of the situations in this part of the state best adapted to the culture of the mango. Many small seedlings planted in cool localities have succumbed to the frosts of winter, but in the milder locations or with some protection during the first few winters, several trees have attained sufficient size to withstand the frosts, and are now doing well, it being a well known fact that if afforded some protection for the first few winters the tree will withstand without injury frosts which would have been fatal to it in the young stage.

At Sierra Madre the mango has probably done best. This is probably due to the absence of severe frosts during the winter, coupled with the intense heat of such a location during the summer, Sierra Madre being directly at the foot of the mountains and receiving a large amount of reflected heat. Here two trees, planted quite a number of years ago and receiving practically no care, are bearing regularly and show that one of the principal requirements of the mango is a warm season of long duration, with high temperatures, for the fruits come much nearer ripening on the tree here than near the coast, where they are subjected to fogs during a great part of the summer and never experience the intense heat found further inland.

Two trees growing in the foothills near Sherman, and only a few miles from the ocean, are in a thrifty condition and bearing well, but also go to show that more heat than is experienced in such a location is necessary for the perfect ripening of the fruit. One of the trees is an inarched Red Number Eleven, sent out some years ago by the Department of Agriculture, and is of great interest on account of being, so far as known to me, the only inarched or grafted mango now bearing in California. This tree demonstrates very clearly some of the differences between a seedling and a grafted tree. It is a regular and prolific bearer, and the fruits are all of a uniform, normal development, a fact rare with the seedlings. If it could have been planted further inland there seems little doubt but that it would be producing first-class mangos, as it is only the lack of sufficient heat that prevents the fruit from ripening perfectly. It is never affected by frost, and one glance at the dark green, healthy state of its foliage is sufficient to satisfy the most skeptical as to the possibility of growing the mango in California.

A five year old seedling near Santa Ana has made a splendid growth and is producing regularly, although rather shyly. Not much can be said as yet as to the adaptability of this locality to the mango, but it would seem that it too lacks the necessary degree of heat during the summer months for the perfect ripening of the fruit, of this variety at least.

At Montecito, near Santa Barbara, there are several trees some sixteen or eighteen years old. These trees have never had a healthy look, and their growth has been stunted and their foliage yellow. From the appearance of other plants in the same vicinity it would seem that this was due more to the soil than to the climate. The trees bear regularly a fair crop of fruit, but it does not mature sufficiently to be of any value.

Figure 68. Seedling mango "No. 5" grown at Sherman, California.

Prof. C. V. Piper, Agricultural Explorer of the U. S. Department of Agriculture, writes as follows regarding the conditions at the Government Botanical Gardens, Saharanpur, India:

"Saharanpur is only a short distance from the Himalayan foothills, and the mercury commonly goes down to about 20 degrees in the winter. It is on this account that both tropical and temperate trees can be grown here successfully It is quite strange to see cherries, plums, pears and even apples growing alongside mangos, dates, guavas, etc. In a general way it is comparable to Chico so far as temperature is concerned, possibly a little hotter in summer, and hardly so cool in winter. Judging from this place, why won't mangos do well in California?"

It would seem that if there are varieties of the mango that will thrive in a locality similar in climatic conditions to Chico, California, which is in the northern part of the state and experiences much more severe winters than the orange growing districts of Southern California, then we can reasonably expect to successfully produce this fruit in the latter districts at least. It is interesting to note that many of the mangos which have proved successful in Florida, and are now under trial in California, were introduced to this country from the Saharanpur. Surely, with varieties which will thrive in a locality experiencing temperatures of 20 degrees above zero every winter, and scarcely hotter in summer than Chico, our chances of success are great!

From this short survey of the behavior of the mango in different localities several conclusions are reached, which it is believed will hold good, although sufficient experience has not yet been had to make them positive. First, the mango, as far as can be judged with the varieties tried out here, is much better adapted to the milder and so called "frostless" localities of the interior than to the seacoast for the reason that near the ocean there is a lack of sufficient heat during the summer months to properly ripen the fruit. It seems reasonable to believe that sheltered locations in the hot interior valleys, such as the San Joaquin, Imperial and Coachella, as free from frost as possible, will produce first-class mangos.

Second, the growth of the tree will be stunted here, and the tree will never reach the proportions attained in tropical countries, although in time it may attain considerable size, especially in the hottest locations.

Third, if given protection for the first few winters the tree will withstand considerable frost, and will be hardy here in many localities at least.

Fourth, the dryness of our climate will not prohibit the production of choice mangos nor seriously interfere with growth in any way, provided ample moisture is supplied at the roots.

It is extremely improbable that the above conclusions will hold good in the case of all varieties, and in fact it could not be expected that they would. The question of variety will have much to do with the success of the mango here, but statements made by many of the greatest authorities on this subject would maintain the contention that a climate such as found in certain parts of Southern California is well adapted to the growth of this fruit.

While there are certain limitations in regard to climate, soil and rainfall, the question of variety must be of great importance in varying these limitations. The mango having become acclimatized in such widely distant localities and under such varying climatic conditions, it is reasonable to believe that a variety which has become adapted to one locality through years of acclimatization would not necessarily be a success in another one of widely differing character.

It is agreed that a dry season of considerable duration is desirable for the most successful culture of this fruit. On this point Collins [The Mango in Porto Rico (Bur. Plant Industry Bul. No. 28) p. 13] states: "It may be considered as proven that the mango will be prolific only in regions subject to a considerable dry season. * * * * In Mexico and Guatemala the mango was found at its

best only where severe dry seasons prevailed." It is argued that rains at the time of flowering interfere with pollination, and that without some artificial means of checking the growth, such as supplied by an extended dry season, the tree is not encouraged to produce fruit." In regard to climatic requirements Macmillan [Handbook of Tropical Gardening and Planting, p. 154] states, "A hot and rather dry climate and a rich, well drained soil suit it best."

Whether or not a high degree of humidity is at any time of the year necessary is perhaps open to question, but it would appear from the statement of Woodrow [The Mango: Its Culture and Varieties, p. 7] that it is not. He says: "The mango requires an abundance of moisture either in the atmosphere or at the root." Higgins [The Mango in Hawaii (Hawaii Ag. Exp. Station, Bul. 12) p. 8] says: "The mango is better suited to an irrigated region than to one of natural rainfall, because of the bad effects of rain at flowering time, and indeed throughout the life of the tree where the mango blight is known; and further, because it is a distinct advantage to be able to apply water when it is most needed and withhold it when it would do harm." And the behavior of the tree in Southern California and in parts of Mexico with extremely dry summers would argue that the necessary moisture can as well be supplied by irrigation as through the atmosphere.

The amount of frost that the tree will stand could scarcely help depending in a large measure on the variety, those which have become acclimatized in cool localities being naturally less susceptible to frost than those from strictly tropical countries. On this point Woodrow [The Mango: Its Culture and Varieties, p. 7] gives the experience in India as follows: "A few degrees of frost for a short time destroys the leaves and young branches, and an occasional blizzard giving 10°F. below freezing point for a short time may destroy branches as thick as the forearm, but on these being pruned off the trees are little worse for the low temperature." It seems, therefore, that the tree will withstand quite low temperatures provided they are of not too long duration. But a high temperature is necessary during the fruiting season. On this point A. C. Hartless, superintendent of the Government Botanical Gardens, Saharanpur, India, states: "As regards the conditions under which the mango ripens its fruit, undoubtedly a high temperature is necessary, and moreover a dry one is preferred. The fruits ripen here from May to July and thus have the hottest and dryest time of the year in which to ripen. Generally there is during May a hot, dry wind that no doubt acts on the acids of the fruit."

It is not necessary that the fruit be ripened on the tree, and the practice of ripening it artificially is extensively used in India. Mr. Hartless says regarding this: "It is a common practice here to ripen the fruit artificially. This is done to save the expense of watching and protecting from predatory animals and birds. When the fruits attain the desired size they are taken off and packed in straw in closed boxes where they will ripen. In this way the taste may differ slightly from those ripened on the tree, but it is not uncommon for fruits on the same tree to differ materially in taste." Mr. H. C. Prinsen Geerligs of Java, writing in the International Sugar Journal, [From The Agricultural News, Barbados, Vol. VIII, No. 176, p. 21] says: "Mangos are usually picked when unripe. At that

time they are hard, acid and flavourless, but the after-ripening process renders them tender and full flavoured in a few days."

Future Possibilities

A careful study of the behavior of the few bearing mango trees in Southern California will leave little room for doubt as to the future possibilities of this fruit here. Past experiments, while limited in extent, and confined chiefly to the seacoast belt, have been amply adequate to demonstrate that the mango will be, some day, a success in California.

But the varieties which have originated here, or been grown here thus far, are scarcely worthy of consideration for future planting on an extensive scale. In India, and other tropical countries, the mango has been grown for centuries and has reached a high state of development, and the existing varieties are so far ahead of anything that could be produced here by many years of breeding and selection that it behooves us not to waste time and effort experimenting along such lines, but to obtain at once for trial in different locations and under varying climatic conditions inarched or budded trees of a great number of the best varieties. By making such an experiment, we can determine without long delay what varieties or types are adapted to this climate, and obtain for cultivation here varieties much choicer than we could develop in many years.

This work has already been started by the Department of Agriculture. A set of inarched trees, comprising about forty of the choicest varieties from India, Ceylon, Philippines and other countries, has recently been sent to several locations in Southern California for trial. The list includes Alphonse, Ameeri, Amini, Bhadauria, Bhurdas, Bombay Yellow, Brindabani, Bulbulchasm, Cambodiana, Carabao, Chickna, Davey's Favourite, Divine, Ennuria, Faizan, Fernandez, Itamaraca, Jamshedi, Julie, Kachmahua, Kistapal, Langra, Langra Hardoi, Langra Large, Malda, Maller, Mulgoba, Mullgoa, Paheri, Punia, Rajabury, Salamar, Sharbati Black, Singapur, Stalkart, Sufaida, Surkha, Totapari, and White Alphonse. Notes regarding these will be found in the appended list of varieties.

By such experiments as this there is little doubt but that a number of choice varieties will be found that are adapted to this climate, and we will be enabled to proceed at once to the production of the finest forms of this valuable fruit.

The mango being so highly esteemed and extensively cultivated in tropical countries there seems no doubt but that the industry will reach large proportions here when choice varieties are found which are susceptible of rapid acclimatization.

Propagation

It is a regrettable fact that up to the present time the mango has been propagated in California exclusively by seed. The entire lack of budded or grafted trees of desirable varieties from which to propagate and the inferiority of the local seedlings have not tended to stimulate attempts at asexual propagation of this fruit. A small number of seedlings has been grown by the nurserymen during the past few years, in order to supply the demand which has existed, but it is to

be hoped that in the future propagation in this way will be utilized only to supply the necessary stocks upon which to bud or graft superior varieties. As with nearly all other tree fruits, the mango does not come true from seed, and trees grown by this method are liable to prove inferior and disappointing in the majority of cases. With all the choice varieties now at our command it will be much more profitable to turn our attention at once to the asexual propagation of those found to be adapted to this climate, than to the development of new varieties through the selection of seedlings.

By Seed: Propagation from seed is most simple, and no difficulties are encountered in growing the mango in this way. It has been found advantageous to remove the husk from the seed before planting, as this not only hastens germination, but does away with loss of seeds from insects or fungous growths which find their way inside the husks. A high temperature favors prompt germination, and for this reason seeds are usually started in a greenhouse. They can be planted singly in 4-inch pots, a light, well drained soil being best suited to the development of the young plant.

Inarching: The simplest method of asexual propagation, and the only one practiced until very recently, is that known as inarching, or grafting by approach. This is the method that has been in use in India for centuries, and by which the choice varieties for which that country is famous have been perpetuated. Inarching provides a simple means for the perpetuation of good varieties, and while somewhat tedious and not suited to the production of trees commercially, propagation in this way may be much more successfully practiced by the inexperienced than budding. The following description of the process from the Sugar Journal and Tropical Cultivator will be of great assistance to those contemplating doing this work:

"The best method of propagating good varieties of mangos is by means of inarching, which is a very simple process. It is performed usually between a large tree of superior variety growing in the ground and a seedling growing in a pot,—small, cheap flower pots about eight or nine inches deep and six inches diameter do well for the purpose. The soil should be good potting soil, with a fair proportion of manure. A single large mango stone should be planted in each pot. The seedlings are ready for inarching, if well grown, in ten months or so; if not well grown, they should be older. Two-year-old seedlings are very successfully inarched. The stem of the seedlings should be in each fairly thick, with the wood fairly developed,—near the root the stem will be somewhat thicker than an ordinary workingman's smallest finger. Any number of seedlings in pots can be inarched in one tree by erecting a stage (for their support) under the lower branches. The stem of the branch to be inarched should be about the same thickness as the seedling, and like the seedling, should be fairly developed wood. The juncture where the inarching is performed should be about six or eight inches from the root of the seedling and about a foot or so from the growing point of the branch, unless the branch is making new vigorous growth, in which case the distance will be more. A straight, well-shaped branch should be selected, so that the future grafted tree will be well proportioned. A slice of wood and bark

should be cut from the seedlings and from the branch, so that the inner bark of both can be made to touch accurately; the two wounded surfaces are bound securely with tape or bast fiber, and grafting clay applied to keep out air. The juncture of branch and seedling should extend for a length of about 3 inches, but at no point should the wound in either be deep; the slices should in fact be of almost uniform thickness throughout and not thick. Tenacious clay should not be used to cover the inarch, it soon cracks and admits air. One part of fresh cattle dung, mixed with two parts good soil, kneaded together with a little water, serves the purpose excellently. Inarching can be done in India at any season, but it is most successful when the trees are in active growth. It takes some time (several months) before the inarched juncture is perfectly joined by the new wood and bark cells. Meantime the seedlings in the pots must be carefully and regularly watered. When the juncture is complete the leading shoot of the seedling should be removed immediately above the inarch juncture and some days afterwards the branch of the tree may be severed immediately below the juncture.

"Trees for inarching should be in a sheltered situation, because if swayed much by the wind the pots or the platform are disturbed from their position.

"In planting out young grafts the pots should be broken if the young plant can not be removed without disturbing the earth on the roots. If the earth on the roots is much disturbed the plant will almost certainly die. They should be planted with plenty of manure in pits three feet deep and wide."—[From "The Mango in Porto Rico." by G. N. Collins, (Bulletin No. 28, Bureau of Plant Industry), p. 15]

PATCH BUDDING: It would be almost impossible to propagate mango trees in sufficient quantities for large commercial plantings by the method of inarching as described above. With the recent development of interest in the extension of the mango industry, several methods of budding, which permit of the propagation of trees in commercial quantities, have been developed. And while these doubtless require considerable more skill and experience on the part of the operator than inarching, when the production of trees in quantity is desired, one of them will have to be resorted to. The first method of budding successfully practiced was that of patch budding, Mr. G. W. Oliver of the Department of Agriculture being the first one to succeed with it in this country. The method as practiced by him is described as follows: ["The Propagation of the Mango," by G. W. Oliver, in the Florists Exchange, New York, April 19, 1902, p. 461.]

"The method I wish to call attention to must be performed under certain conditions, the first and foremost of which is that the stock must be in active growth. The best time is when the new leaves are not far enough developed to show the bright green color. The bark is then most easily removed. Choose the thick part of the stem only a few inches above the surface of the ground; cut out a rectangular piece of bark about one and one-half inches in length, and from the variety to be propagated cut a similar piece with a bud in the center, not, however, from new wood, but from that which is at least two years old and which has lost its green color and assumed the grayish brown tint. Fit the section of bark, with bud attached, into the space formed by the removal of the bark from

the stock. If this piece of bark removed from the stock has a bud in the central part, the wood exposed to view will fit better with the section of bark to be applied. When the section has been put in place, with a small brush apply a light coating of liquid grafting wax in which there is a large quantity of resin, to the cut parts, and immediately tie firmly with thick pieces of raffia; then an 8-inch wide strip of strong wrapping paper wound round and round the stem a few inches above the bud, and tied above with a cord, completes the operation for the time being.

"If good material is selected and the operation carefully carried out at the proper time, there is no reason why a high percentage of successful unions should not be secured."

Shield Budding: In 1910 the Hawaii Agricultural Experiment Station issued a bulletin [Shield Budding the Mango (Bul. No. 20, Hawaii Ag. Ex. Station), Honolulu, 1910] by Mr. J. E. Higgins, describing a method of shield budding successfully practiced by him. Shield budding has several advantages over patch budding, the chief being that the buds can be set much more rapidly, and do not require skilled labor for the wrapping. If it can be successfully practiced here, it should be by far the most desirable method for nursery propagation. Mr. Higgins describes the process as follows:

"Budding by this method has been successfully performed on stocks from an inch to three inches in diameter. What the limitations are, on either side of these dimensions, is not known at present. Wood of this size, in seedling trees, may be from two to five years old. It is essential that the stocks be in a thrifty condition, and still more important that they should be in 'flush'. If not in this condition, the bark will not readily separate from the stock. It has been found that the best time is when the terminal buds are just opening. Unless the trees are watched carefully they will pass this stage before the flush is observed. When the young, brown leaves have appeared it is often too late to bud, and the operation must be postponed until the next flush.

"The budwood which has been most successfully used is that which has lost most of its leaves and is turning brown or gray in color. Such wood is usually about an inch in diameter. It is not necessary in this method of budding that the budwood shall be in a flushing condition, although it may be an advantage to have it so. It should, however, be healthy wood of normal growth.

"The incision should be made in the stock about six inches in length. At the lower end of this make an incision at right-angles to it, with the knife edge pointing upwards at an angle of about forty-five degrees with the stock, thus making a curved incision. Insert the sharpened end of the handle of the budding knife beneath the bark at the junction of these incisions, and push it gently upward, raising the bark so as to make a place for the bud. It is not necessary to push the handle far, but by gently prying, the bark may be separated from the stock, if the latter is in proper condition, without injuring the delicate cells against which the bud shield is to be placed.

"The bud is now to be removed from the budwood. With a rather heavier knife than is generally used for budding, in the right hand, and the budwood held firmly in the left, place the blade against the budwood with a very slight inclina-

tion, and cut so as to make as flat a surface as possible under the bud shield. This bud shield should be about three to three and one-half inches long, with the bud in the center. The small portion of wood, which will thus be taken off with the bud shield, may be removed if it slips readily. If not, it should be left in place. The lower end of the shield is taken between the thumb and finger and gently inserted in the incision prepared for it, pushing it up until it is held firmly in place by the surrounding bark.

"The stock must then be tied with raffia or some other soft, but strong, tying material so as to prevent drying out. The cut surfaces below the actual bud are usually covered with grafting wax, and the whole is then wrapped with a waxed cotton bandage, beginning at the lower part and winding spirally to the top, exposing only the actual bud. This method protects the bud and the wound from the access of water. The bud is shaded by a short piece of bandage hung over it and held in place by being laid under one of the upper strands of the spirally wound bandage.

"In about three or four weeks, if the bud remains green, the stock should be lopped at a point about seven inches above the bud. Care should be taken in thus cutting the stock partly off to avoid splitting downward. It should be made to split upward into that portion of the stock which is to be destroyed. This lopping will serve to force the bud into growth. Many other buds, on the sides of the stock, will start into growth before the new bud. These must all be cut off. It has not been found necessary to remove the tying and wrapping material until the bud has made two flushes, and often it is not necessary at all, since the raffia usually decays beneath the waxed cloth and the latter naturally expands with the growth of the stock. When the bud has started into growth the top of the tree may be cut off and destroyed. The stump remaining above the bud may be cut off with a sloping cut close to the bud, after the latter has made three or four flushes."

Influence of Stock on Scion

Very few experiments have as yet been made to determine the influence of the stock on the scion, and it is to be hoped that this important subject will be more thoroughly investigated in the near future. The following statement, by Prof. Rolfs, demonstrates that the field is an interesting and important one:

"At the present time we know very little as to the influence of the stock on the scion in the various groups of mangos. In this connection I may say that I have two trees of the Totafari, one tree budded on the scion of an unknown variety, probably belonging to the Eleanor group. This small tree began to fruit before it had been set out three years, and has been a constant fruiter and heavy bearer ever since. At exactly the same time that this tree [Rolfs, P. H., 'The Mango in Florida' (Proc. Am. Pomological Society, 1911] was set out, a spring was taken from that tree and marched on a large number eleven tree. This inarch has grown most remarkably and has made a good sized tree, but up to the present time has shown no tendency to produce bloom. One would naturally have expected that when this scion was inarched on the fruiting tree, the scion would

begin to fruit in a very short time. Likewise, I have another case in which a Cambodiana scion has been inarched on to a number eleven mango, and on another limb of the same tree a Pakiri has been inarched. The Cambodiana and Pakiri are of about equal growth. They compose now the entire top of a large mango tree. The Cambodiana has been a regular and constant fruiter, while the Pakiri has shown no tendency to bloom, although some Pakiri trees on what is probably Eleanor stock are blooming and fruiting abundantly. From the isolated instances, it would appear the number eleven proves to be an excellent stock for Cambodiana, but proves to be a poor stock for Pakiri and Totafari groups."

These results seem to indicate beyond the possibility of a doubt that the question of stock is of the utmost importance. It will be both profitable and necessary, therefore, when a choice variety is found adapted to Southern California, to experiment extensively and determine what stock is best suited to it. But the subject will require thorough investigation and experimentation before it is clearly understood.

Varieties

While the following varieties do not by any means include all the mangos so far fruited in California, they may be considered as all which are worthy of notice or liable to be propagated, and hence the only varieties now grown here that it will be necessary to distinguish by name. With one exception, they have originated locally as seedlings. The exception is the variety Red Number Eleven, which, as described, is produced by an inarched tree sent out by the Department of Agriculture. The presence of this one inarched tree is of the greatest interest, and it has demonstrated a number of things which could not be determined by seedlings. Being of a variety whose habits are well known, its behavior can be taken as an accurate indicator of what the mango will do in Southern California, under such conditions as this tree has been grown. It has produced abundantly and regularly, and the fruit has been fully as large as that produced by the same variety in Florida or the West Indies. In addition the fruits are uniformly well developed, which is not the case with the fruits produced by any of the local seedlings. While the growth of the tree has been much slower than it would have been in a hotter country, it is in a healthy and vigorous condition, and is rarely affected by frost, although it has not been subjected to our average winter temperatures, perhaps, on account of being grown in a very mild locality. The locality in which it was grown being near the seacoast, it also lacks the intense summer heat found further inland, and this fact is accountable for the failure of the fruit to ripen perfectly, or even to as great a degree as at Sierra Madre. The cool nights and mild days have the effect of greatly retarding the development of the fruit, so that it reaches maturity just as the winter season is coming on and is unable to ripen for lack of heat. When picked and laid away for awhile, the fruits become soft and eatable but cannot be said to be up to the standard in this respect, by any means.

Most of the seedlings differ from this inarched tree in setting an enormous crop of fruit each year and then bringing only a few to maturity, probably the

earliest blossoms. The great difficulty experienced in many humid tropical countries, namely, the failure of the mango to set fruits, certainly will not be experienced here. But the cool winters check the growth of the tree, and it flowers much later than it normally would, and this results, of course, in making the fruits very late to mature. So that with the seedlings, as with Red Number Eleven, the fruits must be picked and laid away for a few days before softening up sufficiently to become eatable. Those fruits which have been grown farthest inland, and subjected to the greatest heat during the summer, always mature before those grown near the seacoast, and usually are in fact the only ones which mature at all.

Figure 69. The Fales mango. This tree should have been headed lower.

Fales

(Figures 69, 70, 71, 72)

This variety originated at Sierra Madre, on the property formerly owned by W. L. Fales, by whom the tree was planted and for whom it has been named. It

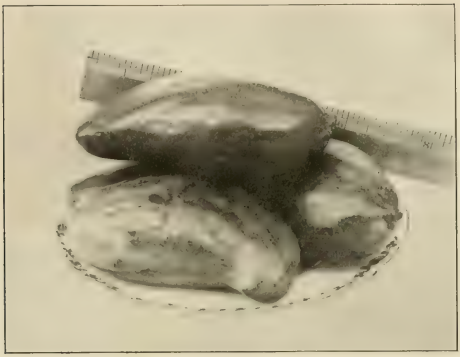


Figure 70. A plate of well developed specimens of the Fales mango.

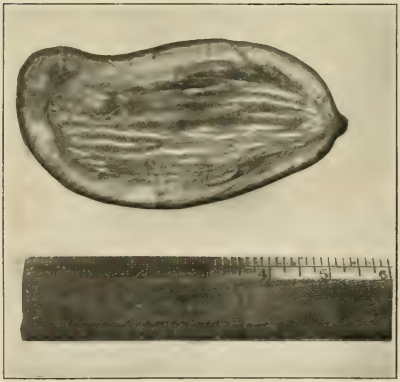


Figure 71. Longitudinal section of the Fales mango grown at Sierra Madre, California.

is probably the best of the local seedlings. This mango would seem to be one of the "Manila" type grown in Mexico, and it is probable that the seed was brought from some point in that republic, and was of that type. The tree has been subjected to the hardest possible usage, and under these conditions its behavior is truly remarkable. It is grown in a partially decomposed granite soil at the foot of the Sierra Madre mountains, and for a number of years has received practically no care whatever. And yet it bears regularly good crops of fruit,—fruit which will compare well in size with those of the Manila type produced in Mexico. If picked in December and laid away for a few days it ripens into a mango of very fair flavor and quality.

Description: General form long and slender, somewhat compressed, and terminating in a prominent curved beak; size large; weight ten ounces; dimensions, length five and one-half inches, width two and three-quarters inches, thickness two

Figure 72. The Fales mango.

inches; base somewhat tapering, slightly extended where stem joins the fruit; apex very prominently curved and beaked, stigmatic point rather prominent and one-quarter inch above tip of beak; stem rather stout; fruits borne in clusters of two to six; surface somewhat undulating; bloom none; color greenish yellow, brightest at base and gradually shading downward to yellowish green at apex; dots numerous, small, rounded, some of them subcutaneous, dark brown, the subcutaneous ones light yellowish; skin medium thick, tough; flesh firm, orange yellow, juicy; fibre not very abundant, fine; seed very long, narrow, medium thick; flavor sweet, aromatic, very pleasant; quality fair to good; matures in December at Sierra Madre, but does not ripen perfectly on the tree.

Tree is upright, close headed, and a fairly prolific bearer. Here described for the first time.

Sierra Madre

(Figures 73, 74)

This also originated at Sierra Madre, and was planted by Mr. Fales at the same time as the variety first described. It is inferior to the Fales, and is mainly noticeable for its habit of producing small sterile fruits, as mentioned below.

Description: General form reniform, long, somewhat compressed, very prominently beaked; size large; weight nine ounces; dimensions, length five inches, width two and one-half inches, thickness two inches; base tapering toward stem, slightly extended where stem joins fruit; apex very prominently curved and beaked, stigmatic point a mere dot; stem medium stout; surface somewhat undulating; color yellowish green, exposed side blushed with brownish orange; dots numerous, small, rounded, some of them subcutaneous, dark brown, the sub-

Figure 73. Normal type of the Sierra Madre mango, grown at Sierra Madre, California.

cutaneous ones light yellowish green; skin medium thick, tough; flesh light yellow, rather dry; fibre rather abundant; seed very large, oblong, rather thick; flavor subacid, strong; quality fair; matures in December at Sierra Madre, California, but does not ripen on the tree.

Tree upright, open headed, fairly prolific bearer. A peculiar thing about this variety is the fact that it produces a large number of small, sterile fruits, which ripen and fall to the ground in October. These sterile fruits are quite distinct in form from the normal type, are about two ounces in weight, and more highly colored than the normal fruits, being a dull orange yellow, overlaid with scarlet and bright orange around the base of the fruit. The seed is represented by a thin, empty husk. The flesh is light orange in color, contains considerable

coarse fiber, and is of a most delicious, sweet, spicy flavor. These sterile fruits are the only mangos known to me which mature in California during the warm season, and consequently have an opportunity to ripen perfectly under favorable conditions. They are really a choice little fruit, and far superior in flavor to any of the normal varieties which mature during the winter and do not ripen perfectly.

This is the first description of this variety.

Figure 74. The Sierra Madre mango. Small sterile form.

Santa Ana

(Figure 75)

Originated near the city of Santa Ana, on the property now owned by Mr. Chas. Eells. It is a common type of mango and a fruit of fair quality, its chief drawback being that it is (so far, at least,) a shy bearer.

Description: General form reniform, rather broad, thick, terminating in a curved beak at apex; size medium; weight seven ounces; dimensions, length four and one-half inches, width two and one-half inches, thickness two inches; base very slightly tapering, more or less plaited; cavity none; apex extended into a prominent curved beak, stigmatic point depressed, one-quarter inch above tip of beak; stem medium stout, swollen where it joins the fruit; surface slightly undulating; bloom none; color yellowish green, blushed with maroon on exposed side; dots numerous, medium large, rounded, sometimes subcutaneous, russet, the subcutaneous ones yellowish green, lighter than skin; skin rather thick, tough; flesh light yellow, sometimes tinged with greenish; fibre fairly abundant, but fine; seed rather long, narrow, thick, reniform, small in proportion to size of fruit; flavor rather acid, quality fair; matures in December at Santa Ana, but does not ripen perfectly on the tree.

Tree is of vigorous growth, but a rather shy bearer, producing only about one dozen fruits this season.

This is the first description of this variety.

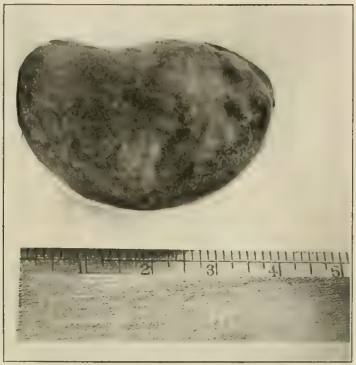


Figure 75. The Santa Ana mango, grown at Santa Ana, California.

Red Number Eleven

(Figures 76, 77, 78, 79)

A red cheeked form of the well known Number Eleven, one of the most popular mangos in the West Indies. The fruit as here described is produced on the property of Ed. Harman, at Sherman, by an inarched tree sent out some years ago by the Department of Agriculture.

Figure 76. The Red Number Eleven mango as now grown at Sherman, California.

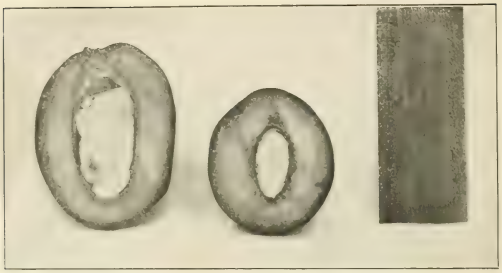


Figure 77. The Red Number Eleven mango as now grown at Sherman, California.

Figure 78. Clusters of fruit on inarched Red Number Eleven mango at Sherman, California.

Description: General form oblong, oblique, somewhat compressed; size small; weight four ounces; dimensions, length three and one-quarter inches, width two and one-quarter inches; thickness two inches; cavity very shallow, sometimes none, slightly plaited; apex rounded, not beaked, stigmatic point slightly depressed and one-half inch above longitudinal apex of fruit; stem rather slender; fruits borne in clusters of two to eight; surface slightly undulating; bloom none; color green, overlaid with magenta on exposed side; dots numerous, medium sized, irregular, russet; skin rather thin, tough; flesh deep yellow to orange yellow; rather dry; fibre slight; seed oblong, thick, very large in proportion to size of fruit; flavor subacid, spicy; quality fair to good; matures December-January at Sherman, California, but does not ripen perfectly on the tree.

Tree is rather spreading in habit, close-headed, of vigorous growth, and a prolific bearer.

Figure 79. The Red Number Eleven mango at Sherman, California. This tree shows a fine orchard form for the mango.

CLASSIFICATION ....

Almost no attempt has ever been made to classify the immense number of mango varieties, either by a natural or artificial system. The one obstacle which has probably prevented this more than anything else is the extremely wide distribution of the fruit, making it an impossibility to gather all the varieties together in one place for study and comparison. There seems to be ample basis for a classification by natural characteristics, and if this could be done it would bring out vividly the relationship between many of the varieties, and establish the synonymy of many which are now considered as distinct, or known under different names in different countries. Few fruits are as widely grown as the mango, or exhibit as many variations, and this will make the task of gathering together and classifying the multitude of forms from all parts of the world a difficult one.

Prof. Rolfs has classified the mangos now grown in Florida into a number of distinct groups, based not only on a similarity of natural characteristics of certain fruits, but also on a similarity in growth and foliage of the trees. It is stated that persons naturally inclined to horticultural work will come to recognize these groups instinctively.

This grouping is as follows:

NO. 11 GROUP. Composed of a miscellaneous lot of seedlings distributed most largely along the east coast from the lower end of India River southward. The group, as far as Florida is concerned, originated in a shipment of about 1200 seeds of No. 11 sent [Rolfs, P. H., "The Mango in Florida" (Proc. Am. Pomological Society, 1911)] from Jamaica. The fruit weighs from three to twelve ounces, varies in color from crimson red to light orange, is quite fibrous, in general shape what has been called a modified kidney shape to almost round, and is the first group to ripen. The group contains two varieties, No. 11, which includes an assemblage of seedling trees, which seem to come more or less true from seed, and Roberts, a descendant from No. 11 which has been propagated by budding to some extent.

TURPENTINE GROUP. A miscellaneous lot of fruits, seeming to have come to Florida from various parts of the Antillean region. It is of so inferior grade that varieties have not been propagated.

CAMBODIANA GROUP. Considered by some botanists to be a distinct species from the other groups of India, and known under the name of Mangifera Cambodiana. It seems to be most common in the Malayan Peninsula and the Philippine Islands. In some instances the seed fails to develop and yet produces a good fruit, that is, the group seems to produce strains which are tending to become seedless. The characteristics of the group are a fruit of six to eight ounces in weight, deep lemon yellow color, weak fiber, much elongated form, and prominent stigmatic area. The varieties at present recognized are: Manila, an assemblage of seedlings that is to eastern Mexico what No. 11 is to the east coast of Florida; Philippine, an assemblage of seedlings grown in Cuba; Cambodiana, grown from seeds imported by U. S. Department of Agriculture; and Cecil, a very handsome variety originated at Miami, Florida.

PINEAPPLE GROUP. Composed largely of seedlings grown in Mexico, some of which have found their way into Florida. It is small in size, light orange or lemon yellow, streaked with red, fiber strong as in No. 11 group, shape distinct, shoulder not prominent, stigmatic area prominent. The varieties are: Pinna, seeds imported from Mexico; Totafari, received as inarched tree from India.

BOMBAY GROUP. This group has no distinct line of demarcation between it and the Eleanor group, which follows. Some of the varieties have come to Florida as seed from the Antilles, others have come from India as inarched trees. As a rule the fruit runs large; the ground color is dark lemon or bright orange in most cases, in some ripening with a distinct greenish color, or containing a considerable amount of red; fiber is rather weak; shape approximates as nearly spherical as any group of mangos; stigmatic area occurs well up on the fruit, where it is either prominent or slightly depressed. Varieties are: Bombay, a miscellaneous lot of seedlings from the Antilles; Indian, a variety of the Bombay group; Mulgoba, introduced by United States Department of Agriculture from India in the late eighties, in form of an inarched tree; Alphonse, derived from India; Bennet, derived from India.

ELEANOR GROUP. A miscellaneous lot of seedlings. Distinct from the Bombay group in color, and in coarseness of fiber. Varieties are: Eleanor, a rather handsome fruit; Apple, quite similar to Eleanor, but of apple-like flavor; Apricot smaller than two preceding, and of apricot-like flavor.

SOONDERSHA GROUP. Comprising a single variety, the only one of the group yet grown in Florida. Derived from India. The largest of the mangos that have been grown in Florida, color somewhat like Cambodiana group, lemon yellow with small dark colorations, fiber weak, season very late. The Soondersha is the only one of the group so far fruited in Florida.

An Annotated List of Better-Known Mangos

Of the almost innumerable varieties of the mango, which have originated in all parts of the tropical world, extremely few have ever been completely described or figured in any publication. Several of the most famous Indian mangos have received considerable attention, but the great majority of varieties are scarcely known even by name outside of the locality in which they have originated. The following list is of necessity very fragmentary, and incomplete, and only contains varieties which have received the attention of horticulturists. One authority records having collected five hundred distinct sorts in India, but no description has ever been published of the majority of these, and there remain vast numbers whose existence has never been recorded.

This list has been compiled in the main from the following sources, but extracts have also been made from a number of articles which have appeared in periodical publications, and I am personally indebted to Mr. E. N. Reasoner of Oneco, Florida, for notes regarding many of the Indian varieties as fruited in that state.

Woodrow, The Mango: Its Culture and Varieties, Paisley, 1904.

Collins, The Mango in Porto Rico (Bureau of Plant Industry, Bulletin No. 28) Washington, 1903.

Higgins, The Mango in Hawaii. (Hawaii Agricultural Experiment Station Bulletin No. 12) Washington, 1906.

Macmillan, A Handbook of Tropical Gardening and Planting, Colombo, 1910.

Jumelle, Les Cultures Coloniales, Paris, 1901.

Hartless, A Tabular List of Mangos grown at the Government Botanical Gardens, Saharanpur, U. P., India.

Yearbooks of the United States Department of Agriculture for 1901, 1907, 1908 and 1910.

Catalog of Government Botanical Gardens, Saharanpur, India, 1907.

Catalog of Tropical Fruit Trees, William Bros., Heneratgoda, Ceylon, 1907.

Catalog of Royal Palm Nurseries, Oneco, Florida, for 1911-12.

Inventories of Bureau of Plant Industry, U. S. Department of Agriculture.

And other publications.

ADA. A good sized, well flavored fruit.—William Bros., Ceylon.

AFONZA, India. Weight eighteen ounces; size four and five-eighths by three and seven-eighths inches; skin greenish yellow with dark specks; pulp very pale yellow, very sweet, slightly wooly; left shoulder high; beak slight.—Woodrow.

ALPHONSE, India. Introduced under S. P. I. No. 8440. (Synonyms *Alphonso*, S. P. I. No. 9517, *Alphonso, Alfonso, Alfoos,* and *Hafu*, S. P. I. No. 8733). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight twelve ounces; size four by three and one-quarter inches; skin greenish yellow, with reddish orange shoulder; pulp fine, dark cream colored, of the finest piquant and delicate flavor; beak none; left shoulder very slight. The keeping qualities of this mango are excellent, and it is generally admitted the best of all mangos. The name is applied to many distinct sorts of greatly varied merits, in the markets.—Woodrow.

A well known Bombay kind, tender in the United Provinces—Saharanpur.

This is the best Bombay mango, and is remarkable for its good shipping qualities. It can be picked while still green, laid or shipped in straw with plenty of air, and kept for six weeks. Even after ripe, fruits can be kept for a week or more. A much better shipper than Mulgoba, and more productive.—Fairchild.

Prolific bearer; medium size; quality good; color red and yellow; stone medium size; ripens mid season; good keeper; very fair flavor; tree tender.—Hartless, Saharanpur.

AMLEBGOLA. Listed, but not described, by William Bros., Ceylon.

AMINI, India. Introduced under S. P. I. No. 7104. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

General form long, about five and one-half inches. Skin medium thick, yellow and red. Flesh meaty, tender, juicy, sweet.—Reasoner, Florida.

Amini has produced fruit as free from adhesion as Fernandez, and of excellent flavor. The shape is more nearly what is desired in a market fruit, i. e., it approaches more nearly to the spherical than most others. It is a very thick and short variety, with no noticeable point at blossom end.—Beach, Florida.

AMRIT OR AMRIOLA, India. (Syn. *Ameeri*, S. P. I. No. 8731). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight ten ounces; size five and one-half by two and seven-eighths inches; crimson yellow on skin shading downward to green. Described as a very high class fruit by Mr. Mahaluxmivalla of Bombay.—Woodrow.

Annurrua. Listed, but not described, by William Bros., Ceylon.

Apple, Florida. Quite similar to the Eleanor. At its best has a decided apple flavor. -Rolfs.

Apricot, Florida. Running somewhat smaller than either the Eleanor or the Apple. At its best has a decided flavor like the apricot.—Rolfs.

Arbuthnot, India. Introduced under S. P. I. No. 9504. Fruited in Florida.

A medium sized fruit, near the Bombay variety.—Saharanpur.

Prolific bearer; medium size; quality medium; color orange and green; stone medium size; mid season; good keeper; flesh firm; tree tender; slow grower.—Hartless, Saharanpur.

The fruits are rather long, weighing from eight to twelve ounces each, of excellent flavor and very little fiber.—Reasoner, Florida.

Aristide, Mauritius. Introduced under S. P. I. No. 27926. The best of our mangos.—Regnard.

Auguste, Mauritius. Introduced under S. P. I. No. 27853.

Aumini. Listed, but not described, by William Bros., Ceylon.

Bada Mawa, India. Weight six ounces; size three and five-eighths by two and three-quarters inches; skin green, speckled pale green, and shaded yellow; pulp sweet and luscious, without piquancy.—Woodrow.

Badami, India. Introduced under S. P. I. No. 7103.

Badshaha, India. Weight fourteen ounces; size four and three-quarters by three and three-eighths inches; skin pale yellow, of agreeable flavor but woolly; beak small; shoulders yellow.—Woodrow.

Bahadura, India. A small fruit of fine flavor, ripens in August and September.—Saharanpur.

Baissac, Mauritius. Introduced under S. P. I. No. 27927.

Banchore of Alandi-Keir, Poona. India. Weight four and three-quarters ounces; size three by two and one-half inches; skin deep crimson on exposed side, dark cream on shaded side; pulp very fine, creamy, delightfully piquant; beak none; shoulders level. —Woodrow.

Banchore of Dhairey, Poona. India. Weight seven ounces; size three and one-third by two and three-quarters inches; skin green, speckled pale green and shaded yellow; pulp very sweet, and luscious, without piquancy.—Woodrow.

Banka, India. A twisted variety, highly popular.—Woodrow.

Baramasi, India. (Synonymous with *Baromeshe* and *Baransi*). Fruits during several months of the year.—Saharanpur.

Baransi, India. Prolific bearer; fruit small; quality fair; color yellow and green; stone large; ripens late; keeps well; fruits twice a year, latest to fruit; rather fibrous; medium hardy; slow grower.—Hartless, Saharanpur.

Baromeshe. Or all the year round.—William Bros., Ceylon.

Batasi, India. A very small fruit of delicious flavor and very rare, with fine fibre. Beak none, left shoulder slightly higher.—Woodrow.

Bath, India. Introduced under S. P. I. No. 7038.

Belkash. Listed, but not described, by William Bros., Ceylon.

Bennett. Syn. *Douglas Bennett Alphonse*, which see.

Beresa. Listed, but not described, by William Bros., Ceylon.

Bhadaya. A late fruiting variety, ripens August to October, and one of the best as to flavor.—William Bros., Ceylon.

BHADAUREA OR BHADUREA, India. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; size large; quality fair; color yellow and green; stone large; ripens late; poor keeper; texture fibrous; poor flavor; tree hardy; medium free grower.—Hartless, Saharanpur.

BHAO KAN. Listed, but not described, by William Bros., Ceylon.

BHOPALY, India. Weight fourteen ounces; size four by three and one-eighth inches; skin yellowish green; pulp deep yellow without fibre; flavor pleasing; beak none; shoulders level.—Woodrow.

BHUNGA, India. Weight eight ounces; size three and one-third by two and seven-eighths inches; skin yellow; pulp yellow, shaded dark yellow in center. Infested with mango weevil. Beak very slight; shoulders level.—Woodrow.

BHURDAS, India. Introduced under S. P. I. No. 9515. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; medium size; quality medium; color yellow and green; stone large; ripens mid-season; good keeper; pineapple flavored; medium hardy and free grower.—Hartless, Saharanpur.

BISHOP, India. Weight eighteen ounces; size five and three-eighths by four and one-half inches; skin yellowish with very small bright light yellow specks; pulp deep brownish towards stone, shading off to pale at the outside; slightly wooly, sweet and rich, without piquancy; beak scarcely perceptible; left shoulder slightly high.—Woodrow.

BISSANETH MUKHO. Listed, but not described, by William Bros., Ceylon.

BLACK (or *Green Gage*). A delicious mango from Jamaica, where it is considered their best sort. Small to medium size; regular oblong; green, with numerous black spots on the skin; pulp with exceedingly fine fiber hardly noticed, of a yellow color, and spicy, sweet flavor.—Reasoner, Florida.

BOLO, India. Weight thirteen ounces; size four by three and one-half inches; skin yellow; pulp pale yellow, with a few strong, dark fibers near skin; beak and shoulders none.—Woodrow.

BOMBAY BILUTO OR BILUTA BOMBAY. Listed, but not described, by William Bros., Ceylon.

BOMBAY CALCUTTA GARDEN, India. Prolific bearer; large size; second quality; color green and yellow; stone small; tree hardy; ripens midseason; keeps well; medium free grower; good flavor.—Hartless, Saharanpur.

BOMBAY GREEN, India. Introduced under S. P. I. No. 9507. Now under trial in Florida.

One of the best kinds for general planting, prolific bearer.—Saharanpur.

Prolific bearer; medium size; quality good; color green; stone medium size; hardy; ripens early; keeps well; medium free grower; soft fleshed.—Hartless, Saharanpur.

BOMBAY JAIT. Listed, but not described, by William Bros., Ceylon.

BOMBAY SINGA. Listed, but not described, by William Bros., Ceylon.

BOMBAY SURAT. Listed, but not described, by William Bros., Ceylon.

BOMBAY WHITE. Listed, but not described, by William Bros., Ceylon.

BOMBAY YELLOW, India. Introduced under S. P. I. No. 9508. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

One of the best for general planting. A prolific bearer.—Saharanpur.

The best mango here. Fruit of medium size and yellowish when ripe. Gollan, Saharanpur.

Prolific bearer; medium size; first quality; yellow and red in color; stone medium size; hardy; ripens mid season; keeps well; free grower; flesh firm; superior to Bombay Green.—Hartless, Saharanpur.

Borsha, India. Introduced under S. P. I. No. 8442.

Weight ten ounces; size four and one-eighth by two and five-eighths inches; skin bright green, with minute yellow spots and bright crimson on exposed side; beak very slight; left shoulder very high.—Woodrow.

Fruit weighs on an average ten ounces, ripens by first of July. Flesh is as dry as that of Mulgoba or Alphonse and can be cut like cheese. It is three to four weeks later in ripening than Alphonse and considered almost its equal in quality. One large tree of this variety is said to have often yielded over $150.00 worth of fruit in a single crop. * * * This variety is distinguished from Mulgoba by its young shoots, which are distinctly reddish in color.—Fairchild.

Bottle, India. Introduced under S. P. I. No. 8420.

A good market sort of Bombay. Green in color, ripening to reddish yellow. Flesh is yellowish in color and not stringy. The fruit is very long and slender, hence the name "bottle." The stone is small. The fruit ripens, as do most of the Bombay mangos, from April to May.—Fairchild.

Brindabani, India. Introduced under S. P. I. No. 9506. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Medium sized, green colored fruit. Quality only fair. Gollan, Saharanpur.

Sparse bearer; size small; quality only fair; color green and yellow; stone large; tree tender; ripens midseason; keeps well; slow grower; juicy and of good flavor.—Hartless, Saharanpur.

Brojonath Dhur (or *Brojo Nath Dhar*). Listed, but not described, by William Bros., Ceylon.

Bulbulchasm, India. Introduced under E. P. I. No. 9519. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; medium size; second quality; color green and yellow; tree hardy; stone medium; keeps well; ripens medium; free grower; ordinary—Hartless, Saharanpur.

Calcutta Amin, India. Introduced under S. P. I. Nos. 9520 and 10644. Now under trial in Florida.

A long fruit, hooked and pointed. Has a very thin stone. Flavor good.—Gollan, Saharanpur.

Sparse bearer; large size; second quality; color reddish; stone small; tree hardy; ripens medium; keeps well; medium free grower; ordinary.—Hartless, Saharanpur.

Cambodiana, India. Introduced under S. P. I. No. 8701. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A very rapid grower, bearing medium to large fruit; early ripening, color yellow; shape long; rather more acid than most sorts if gathered before coloring, but when ripened on the tree is quite sweet. Very fine sort without any turpentine taste.—Reasoner, Florida.

Much like Totapari, but not so pointed. Free bearer.—Beach, Florida.

Carabao, Philippine Islands. Introduced under S. P. I. Nos. 24927 and 25659. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A variety of merit. It comes true from seed and by that method has been reproduced in that country (Philippines) for generations.—MacIntyre.

Cecil, Florida. Form oblong reniform, rather slender; size large; cavity regular, small, shallow, slope gradual; stem medium slender; fleshy where it joins the fruit; tip an inconspicuous beak, usually about half an inch from the longitudinal apex of the fruit; surface nearly smooth; color rich greenish or golden yellow, marbled lightly with brownish yellow; dots numerous, russet, sometimes subcutaneous, green or gray; bloom whitish; skin medium thick, tenacious; flesh yellow, tender, juicy, with but very little fiber; seed thin, oblong, large; flavor sweet or mild subacid, rich, aromatic, pleasant; quality good to very good; season June to August at Miami, Florida.

Tree is said to be a very vigorous grower, symmetrical in form, and a heavy bearer. The fruit begins to ripen at Miami about the first week in June.—1910 Yearbook, U. S. Dept. of Agriculture.

Originated at Miami, Florida.

CHICKNA, India. Introduced under S. P. I. Nos. 9521 and 10660. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A medium sized fruit, light yellow, of good flavor.—Gollan, Saharanpur.

Prolific bearer; small size; quality only fair; color reddish green; stone small; tree hardy; ripens medium; keeps well; free grower; ordinary.—Hartless, Saharanpur.

CHINA of Guatemala. A very fine seedling race, common in the markets of Guatemala City, and considered the finest mango of that region. The form of the fruit is characteristic, being very thin and almost circular in outline, with a prominent blunt "nak" located some distance from the apex. The flesh is thick and remarkably free from fiber for a seedling, mild and aromatic, without suggesting turpentine.

This variety differs from others examined in having pronounced longitudinal ridges on the seed, which is thin and very broad. Like the Manila of Mexico, this form apparently comes true to seed. By some this form is called Mango de Brea. This name is, however, more appropriately applied to another form in which the fruit is more or less coated with a pitch-like exudation, *brea* meaning pitch.—Collins.

CHINA of Hawaii. Size very large, one of the largest mangos in Hawaii; form resembling the Strawberry mango, with a slightly depressed stem; color a shade of yellow on the unexposed side, and on the exposed side varying from orange to orange red; peeling qualities good; texture good; flesh abundant in proportion to the size of the seed, very bright in color like that of the Vanilla mango; flavor rather lacking in delicacy, though sweet. It would seem that this variety, the Vanilla, and the so-called Strawberry are all closely related. There is a similarity of flavor, form and odor of flesh. They differ in size and color of rind.—Higgins.

CHITTORO. Listed, but not described, by William Bros., Ceylon.

COBRIA, India. Weight six ounces; size two and three-quarters by two and three-quarters inches; skin smooth, yellowish green; pulp pale yellow, of fine flavor, no fiber; beak none; shoulders level.—Woodrow.

COLLECA, India. Weight ten ounces; size four and three-eighths by two and five-eighths inches; skin yellowish green; pulp shaded yellow, sweet, no fiber, a cooking fruit; beak very slight and broad; right shoulder slightly lower than the left one.—Woodrow.

COSTA, India. Weight eight and one-half ounces; size three and five-eighths by two and seven-eighths inches; skin yellowish green; pulp cream, of pleasant flavor; beak very slight; left shoulder very broad and slightly high.—Woodrow.

COWASJEE PATEL, India. Introduced under S. P. I. No. 7045. Synonymous with *Kavasji-Patel*, which see.

CRESCENT, Hawaii. Size medium to large; form crescent shaped, with a tendency toward greatest enlargement on the exposed side, even when ripe. In ripening, the exposed side takes on tinges of yellow, and when fully ripe becomes a shade of orange yellow. Peeling qualities poor; texture very good, quite free from fiber; flavor excellent, sweet, and spicy; flesh light yellow with a slight tinge of green, except at the center close to the seed, where it is quite bright, approaching yellow-orange; seed very thin and long, resembling the fruit in outline, greatly reduced within the husk and showing a tendency toward seedlessness. This is one of the most desirable of the sweet seedling mangos.—Higgins.

CRASSOUS, French West Indies. Oblong, clear green outside, very little fiber.—Jumelle.

CUILLER, Mauritius. Introduced under S. P. I. No. 27854.

Custodio, India. Weight twenty-eight ounces; size six by four and one-eighth inches; skin yellowish green; pulp pale yellow, no fiber; season begins in July. Beak slight; left shoulder very high.—Woodrow.

Dalbed, India. Weight ten and one-half ounces; size four and three-eighths by two and seven-eighths inches; skin yellow, shaded with green; pulp deep yellow, very sweet, but very fibrous; fruit stalk insertion high; left shoulder higher than right; beak medium.—Woodrow.

Damaria, India.

Dampara, Ceylon. Prolific; fruit small in size, of second quality, rather fibrous; skin yellow brown; seed small; ripens early and keeps fairly well. The tree is a free grower and is hardy. It is not much cultivated.—Dr. Drieberg.

Davey's Favourite, India. Introduced under S. P. I. Nos. 9522 and 10661. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A long thin fruit, yellow shaded red. A fine fruited variety.—Saharanpur.

Sparse bearer; medium size; second quality; color green; stone medium size; tree tender; ripens mid season; keeps well; free grower; somewhat sour.—Hartless, Saharanpur.

Davis No. 11, Hawaii. This is a seedling from the No. 11 mango, which has attained considerable fame in the West Indies and appears to come quite true to kind, as this variety is reported to do with a fair degree of accuracy. It was introduced by Mr. Henry Davis and has received his name to distinguish it from another and very inferior form which has been known locally as the "No. 11." Size medium; form short, rounded, much depressed at the stem end; color light green, turning to orange yellow in ripening; peeling qualities excellent; texture very good; flavor excellent; color of flesh very dark; seed small.—Higgins.

Deobukhia, India. Weight seven ounces; size four by two and one-half inches; skin clear orange; pulp deep yellow; very fine flavor; habit upright, vigorous; a first class mango; left shoulder slightly raised, right shoulder depressed; beak very slight.—Woodrow.

Dilpassand, India. A very small leaved variety, described as of excellent flavor.—Woodrow.

Diniz, India. Weight eleven ounces; size three and five-eighths by three inches; skin dark green; pulp yellow, very soft, creamy, sweet, without piquancy; shoulders level; beak very slight.—Woodrow.

Divine, French West Indies. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Elongated, slightly flattened, light brown pulp; no fiber. Strong turpentine flavor. A close relative of the Chinese mango.—Jumelle.

D'Joao, India. Weight thirteen ounces; size four and one-half by three and one-half inches; left shoulder high and broad; beak none. A popular fruit.—Woodrow.

Dofasli. Listed, but not described, by William Bros., Ceylon.

Dophala. Listed, but not described, by William Bros., Ceylon.

D'Or, French West Indies. Introduced under S. P. I. No. 28085. Fruited in Florida.

Douglas Bennett's Alphonse, India. Introduced under S. P. I. Nos. 8419 and 8727. (Synonyms, *Bennett* and *Bennett's Alphonse*). Fruited in Florida.

In size it is three by four inches, and in color a golden yellow when ripe. The flesh is quite without stringiness, stone small, and flavor, according to Mr. Bennett, the best in the world. It is a large leaved variety and forms a good sized tree, but is of scraggly growth.—Fairchild.

Considered one of the best yet fruited in Florida. Medium sized, highly colored, very prolific.—Reasoner, Florida.

Fruit nearly round, with short, blunt, curved point at blossom end, obliquely impressed on one side. Pale greenish yellow in color, occasionally shaded with pink on

exposed side. Weight eight to twelve ounces. Skin firm and tough, flesh pale yellow, melting and juicy, slightly acid with pleasant aromatic flavor. Seed medium small and thin. Fiber very short and coarse, tree strong grower.—Cellon, Florida.

Its fruit is smaller than Mulgoba, running from eight to twelve ounces, while the former runs from twelve to sixteen. In flavor and aroma as well as other qualities it is equal to Mulgoba, differing enough to make some prefer one, some the other, according to individual taste. So far as it has been tested it appears to be more prolific than the former, and we presume as good a shipper, though it has not yet had the test of time to determine. This is the only one of the famous Alphonse type that has fruited with us yet.—Beach, Florida.

DULCE, India. Weight twelve ounces; size four and three-eighths by three and one-quarter inches; skin pale greenish yellow; sweet piquant, no fiber; shoulders level; beak slight. Woodrow.

DUN OF TWICE BEARING. Listed, but not described, by William Bros., Ceylon.

DURMA, India. A round yellowish mango about eight ounces to one pound in weight. It has an exquisite vanilla flavor.—C. Maries, Woodrow.

ELEANOR, Florida. A rather handsome fruit which gives a name to a group. It has considerable of a reddish blush, over the yellow ground color.—Rolfs.

ENNUREA, India. (Sometimes spelled *Ennuria*). Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A very large fruiting variety.—Saharanpur.

Sparse bearer; large size; first quality; color yellow and green; seed long and thin; tree tender; ripens medium; does not keep well; slow grower; flesh firm and good flavored.—Hartless, Saharanpur.

Medium sized, oblong, highly colored, exquisitely flavored, mid season in ripening. Has a very little fiber.—Reasoner, Florida.

FAIZAN, India. Introduced under S. P. I. No. 9523. (Sometimes spelled *Fizan*). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A large long fruit, brownish green, flavor good. Gollan, Saharanpur.

Sparse bearer; medium size; second quality; yellow and green; stone small; tree hardy; ripens medium, keeps well; free grower; very good flavor. Hartless, Saharanpur.

FAJRI LONG and FAJRI ROUND. See *Fijri Long* and *Fijri Round*.

FAQIRWALA, India. Introduced under S. P. I. No. 9526. Fruit superior.—Saharanpur.

Sparse bearer; fruit large; first quality; color yellow; stone medium sized; tree hardy; ripens late; keeps well; free grower; very good.—Hartless, Saharanpur.

FERNANDEZ, India. Introduced under S. P. I. No. 7039. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight six ounces; size three and one-eighth by two and one-half inches; skin on exposed side bright red, with small yellow specks, gradually shading downward, and on sheltered side to yellowish green; pulp bright yellow, fiber very slightly wooly; flavor very fine, sweet and piquant; shoulders both low; beak scarcely perceptible. A very superior sort.—Woodrow.

Fernandez is a small fruit, with a bright red cheek, and small seed. It is the only one of the imported sorts so far that has a distinct sub-acid flavor. Some specimens are so absolutely free from fiber that by making an incision around the center of the fruit, the bottom half of the pulp with the skin can be slipped off from the seed, like a freestone peach. It has very distinctive foliage, and is further distinguished from all others by a whitish bloom which covers the new bark so long as it remains green, disappearing only when the latter turns brown with age. Beach, Florida.

Fernandino, India. Weight nine and one-half ounces; size three and seven-eighths by two and seven-eighths inches; skin bright crimson on the upper half, shading to pale yellow at the lower end; pulp very pale yellow, sweet and of piquant flavor, but wooly; left shoulder level, right shoulder low; beak none.—Woodrow.

Fernandino II, India. Weight ten ounces; size four and three-eighths by three and three-eighths inches; skin green; pulp white, a cooking mango of special value; left shoulder level, right shoulder low; beak none.—Woodrow.

Fifine-Gabrielle, French West Indies. Listed, but not described, by Jumelle.

Fijri Long, India. Introduced under S. P. I. Nos. 9524 and 10646. (Sometimes spelled *Fajri Long*). Now under trial in Florida.

A large, longish fruit, ripens late. Dark green when ripe.—Gollan, Saharanpur.

Sparse bearer; large fruit; second quality; green in color; stone medium size; tree hardy; ripens late; keeps well; medium free grower; very fair.—Hartless, Saharanpur.

Fijri Round, India. Introduced under S. P. I. Nos. 9525 and 10647. (Sometimes spelled *Fajri Round*). Now under trial in Florida.

Similar to Fijri Long, but roundish shape.—Saharanpur.

Sparse bearer; large size; second quality; green in color; stone medium size; tree hardy; ripens late; keeps well; medium free grower; very fair.—Hartless, Saharanpur.

Frederico, India. Weight eight ounces; size three and one-half by two and seven-eighths inches; no fiber. Gathered while green. A valuable preserving fruit. Left shoulder level; right shoulder slightly lower; beak slight.—Woodrow.

French, Hawaii. Sometimes locally known under this name, a term whose significance is uncertain. It might well be called the Wine, because of its exceedingly beautiful wine-colored rind, which takes a very high polish if gently rubbed with a soft cloth. Size medium to large; form oblong, rounded; texture fair; peeling qualities good; flavor rather too strong for the average taste.—Higgins.

Freycinet, French West Indies. Rosy outside, reddish pulp, without fiber.—Jumelle.

Friel, Hawaii. Size small; form resembling on side view the Davis No. 11, but viewed from the back it shows a rather gradual narrowing toward the stigmatic end; stigmatic point depressed; forming a small hole where there is often an elevation; stem very slightly depressed; color on the exposed side orange yellow when fully ripe, the unexposed side lighter, mingled with green; peeling qualities fair; texture fair; flavor fair; color of flesh light. Both this and the Walnut would probably be considerably changed by cultivation. They are now much neglected.—Higgins.

Furtado, India. Weight eleven and one-half ounces; size four by three and one-eighth inches; skin smooth, green, becoming rich yellow green; pulp deep orange, puffy, rather coarse; left shoulder high and broad, right shoulder level; beak none.—Woodrow.

Furtado II, India. Weight eight ounces; size three and one-third by three inches; skin yellow and green in blotches; pulp dark yellow; flavor rather high; left shoulder slightly high; right shoulder slightly low; beak very distinct, one-quarter inch.—Woodrow.

Fusli Bewa, India. (Syn. *Fuzli*, of William Bros., Ceylon). Is said by Maries to bring 1 rupee each. August is its season.—Woodrow.

Gada Mar, India. Introduced under S. P. I. No. 7107.

Gadgya, India. Weight eighteen ounces; size four and one-half by three and seven-eighths inches; skin greenish yellow, pulp pale yellow, of piquant flavor, slightly fibrous; shoulders nearly level; beak slight but distinct.—Woodrow.

Ganchir. Most renowned.—William Bros., Ceylon.

General Gordon. See *Gordon*.

GOA, India. (Syn. with *Goa Alphonse*). Now under trial in Florida.

Weight seven ounces; size three and one-eighth by two and seven-eighths inches; skin pale yellow; pulp very soft, sweet; left shoulder high, right shoulder low; beak none.—Woodrow.

GOLA, India. Introduced under S. P. I. Nos. 9527 and 10662. Now under trial in Florida.

A variety with small round yellow fruit. Flavor superior.—Saharanpur.

Sparse bearer; medium size; second quality; color green and yellow; stone medium size; tree hardy; ripens late; keeps well; free grower; juicy, of good flavor.—Hartless, Saharanpur.

GOLAPKHASH. Listed, but not described, by William Bros., Ceylon.

GOLLAN, India. Our own importation from Saharanpur, named in honor of the late Superintendent of Government Gardens there. Fruit large, oblong, weighing from twelve to twenty-four ounces each; pale yellow in color. Small quantity of fiber; flavor excellent.—Reasoner, Florida.

GOPALBHOG, India. Introduced under S. P. I. No. 9509. (Synonyms, *Gopal Bhog, Gopalbogh, Gopal Bhoga* and *Gopalbhogy*). Fruited in Florida

A superior variety coming into market at the end of June. Weight six ounces.—Woodrow.

Prolific bearer; medium size; first quality; color green and yellow; stone medium size; tree hardy; ripens medium; keeps well; free grower; pleasant aroma.—Hartless, Saharanpur.

GOPAL DHOBA. Listed, but not described, by William Bros., Ceylon.

GORADYA, India. Weight twelve ounces; size four and one-eighth by three and seven-eighths inches; skin very rough, with large obtuse projections; pulp sweet but wooly; left shoulder high, right shoulder low; beak indistinguishable.—Woodrow.

GORDON, West Indies. (Syn. *General Gordon*). Fruited in Florida.

This is probably the smallest fruit in our collection, averaging around six ounces. Short, kidney shaped, flavor delicious, high color, quite prolific.—Reasoner, Florida.

This variety is rather dwarf in habits, which renders it suitable for cultivation where space is limited or protection is necessary. Introduced by the U. S. Dept. of Agriculture from Trinidad, West Indies. Fruit long, yellow, shaded on exposed side with carmine; pulp fine, rich and melting, with pleasant aroma, and scanty fiber, confined mostly to the thin edges of the seed. The trees come into bearing while very young.—Cellon, Florida.

GREEN GAGE. Synonymous with *Black*, which see.

GREEN FLESH, Hawaii. Size small, form resembling the common Hawaiian Sweet; color a bright green with traces of yellow and brown on the exposed surface; peeling qualities good; texture poor; flavor sour and unpleasant; seed long, thin.—Higgins.

HADEN, Florida. Originated from a seedling planted by the late Captain J. A. Haden at Coconut Grove, Florida, whose name it bears, and is apparently of the East Indian type.

Size medium to large; shape oblong, nearly round, only slightly impressed on one side at blossom end, which is nearly the same size in circumference as the stem end, making it of convenient shape for packing; color rich golden yellow, washed over the greater portion of the surface with rich crimson and scarlet; skin smooth, tough and of firm substance, medium thin; flesh golden yellow color; flavor rich, aromatic and spicy; seed medium small, fiber short and coarse, extending only from the thin edge of the seed; quality best; season July. The fruit can be easily separated in halves and the seed extracted without leaving any fiber in the pulp, which can be eaten from the fruit with a spoon. Cellon, Florida.

HAFF. Synonymous with *Alphonse*, which see.

HASTINGS. Listed, but not described, by William Bros., Ceylon.

Hathijhul, India. Introduced under S. P. I. No. 9258. (Sometimes spelled *Hathi Jhul*. S. P. I. No. 10648). Now under trial in Florida.

A variety with a very superior flavored fruit, one of the best. A very large fruit. Saharanpur.

Moderate bearer; fruit large; second quality; green and yellow; stone small; tree hardy; ripens late; keeps well; free grower; the largest fruiting kind, and of good quality.—Hartless, Saharanpur.

Hawaiian Sweet, Hawaii. (So called). This was the first variety to be introduced in the islands, having come probably from Mexico. It is now found everywhere in Hawaii where mangos are grown. Size medium; stem depressed; color light green with slight brownish tints before ripening, the green changing to yellow and the brown to pink as ripening proceeds; flavor good when well grown; juices abundant; texture fibrous; seed large; tree a free bearer.—Higgins.

Heart, Ceylon. This is also called the *Bombay* and is the commonest variety found on the market. Prolific; fruit medium in size, not much longer than broad, of second quality; skin golden yellow; seed of medium size; ripens early and is a fair keeper. The tree is a free grower and is hardy.—Dr. Drieberg.

Herbert No. 9, Hawaii. The seed from which this variety was grown was introduced at the same time as the No. 9, and was supposedly identical, being planted under the same number. The fruit, however, is very distinct, but bears a close resemblance to No. 9. The writer has designated it in honor of Mr. Allan Herbert, who planted the tree. Size rather smaller than No. 9; form resembling that variety, but with the peculiar "S" shape, still more marked; color dark yellow when ripe, with a very beautiful bright red on exposed side, thus making it very distinct and one of the most attractive mangos. In other respects it is similar to No. 9, but is apparently more subject to blight.—Higgins.

Himsagar. Listed, but not described, by William Bros., Ceylon.

Honey, Ceylon. A small roundish fruit, of sweet flavor.—Macmillan.

Inerma, India. A Durbhanga variety of great size. Reported four pounds in weight.—Woodrow.

Itamaraca, Brazil. Introduced under S. P. I. No. 23426. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A small yellow mango with a thin skin, without fiber, and with a very delicate flavor, bringing a high price in the market. Occurs in Pernambuco. (Bello)—Bureau of Plant Industry.

Jaffna, Ceylon. Introduced under S. P. I. Nos. 8411 and 8680.

Large oval fruit of excellent quality when well grown; probably equal to *"Alphonso"* of India.—Macmillan.

A long fruited, medium sized mango, green in color. The seed is fairly large, flesh golden yellow. It is edible before fully ripe. A vigorous grower and a good bearer. This is the best market mango in Ceylon, and is the one generally planted about the villages.—Fairchild.

The favorite variety here. Prolific; fruit medium in size, twice as long as broad, of first quality; skin green; seed of medium size; ripens early and is a fair keeper. The tree is a fairly free grower and is hardy.—Dr. Drieberg, Ceylon.

Jalibandha. Synonymous with *Maldo*, which see.

Jamshedi, India. Introduced under S. P. I. No. 8734. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Skin thick, tough, shrivelled, blotched yellow and green, intruded at apex (almost like an apple). Tip rounded; beak short and strong; pulp yellow with a brownish tinge, free from fiber; flavor strong, excellent, distinct. (R. K. Bhide)—Woodrow.

Japan. Listed, but not described, by William Bros., Ceylon.

JAVA. Listed, but not described, by William Bros., Ceylon.

JAVA of Hawaii. Synonymous with *Kauai Chutney*, which see.

JEEPRIA, India. Weight twelve ounces; size four and three-eighths by three and one-eighth inches; skin green when brought to market, pulp pure white, a good cooking sort; both shoulders low; beak none.—Woodrow.

JOBOS, Porto Rico. A common form in the San Juan market in the early part of the season. A very poor kind, considered to be the wild or unimproved form. It is green in color, with a large seed, and very stringy meat, frequently ripening unevenly and having a strong turpentine flavor. In form it is slightly asymmetrical, stem not depressed.—Collins.

JOHNSON. Listed, but not described, by William Bros., Ceylon.

JOSE, Mauritius. Introduced under S. P. I. No. 27855.

JOSEPHINE, French West Indies. Listed, but not described, by Jumelle.

JULIE, French West Indies. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry. Listed, but not described, by Jumelle.

KABUTRIA, India. Weight seven ounces; size four and three-eighths by two and one-half inches; skin greenish yellow, red on shoulder; pulp deep yellow, without fiber, of rich piquant flavor; shoulders nearly level; beak small but distinct.—Woodrow.

KACHAMITHA, India. The fruit of this variety is sweet and eatable when in a green, unripe state.—Saharanpur.

Prolific bearer; fruit small; first quality; red and green in color; stone medium size; tree hardy; ripens early; keeps well; free grower; very sweet even when unripe.—Hartless, Saharanpur.

KACHMAHUA, India. Introduced under S. P. I. Nos. 9527 and 10649. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

KAELIA, India. Weight fourteen ounces; size three and seven-eighths by three and one-eighth inches; skin greenish yellow; pulp deep yellow; flavor luscious; fibres few; left shoulder high, right shoulder low; beak very slight.—Woodrow.

KAGDI-ALPHONSE, India. Weight ten ounces; size three and seven-eighths by three and one-eighth inches; skin greenish yellow, suffused with crimson; pulp deep yellow, fine, creamy; left shoulder from the stalk falling slightly, then rising; right shoulder gently falling; beak none. A thick-skinned Alphonse mango.—Woodrow.

KAKARIA, India. Introduced under S. P. I. Nos. 9530 and 10650.

A large fruited, dark green mango. Good flavor.—Saharanpur.

Prolific bearer; fruit small; second quality; color yellow and red; stone medium; tree hardy; ripens mid season; keeps well; free grower; good flavor. Hartless, Saharanpur.

KALA, India. Introduced under S. P. I. Nos. 9531 and 10666.

A longish shaped fruit. Free of stringiness. Pale green, good.—Saharanpur.

Sparse bearer; medium size; second quality; color dark green; stone medium; tree hardy; ripens mid season; keeps well; free grower; juicy and nicely flavored. Hartless, Saharanpur.

KALA ALPHONSE, India. Introduced under S. P. I. No. 7041. (Syn. *Kala-Alfons*).

Weight fourteen ounces; size four and five-eighths by three and three-eighths inches; skin dark green with red on shoulder; pulp fine, dark yellow, creamy; flavor luscious; no fiber; left shoulder level, right shoulder low; beak very slight, obtuse.—Woodrow.

KALIA, India. Weight nine ounces; size four by three and one-fourth inches; skin dark green, slightly yellow on shoulder; pulp pale yellow, very sweet; left shoulder high, right shoulder low; beak distinct, small.—Woodrow.

Kanchamitha (Panchananda). Listed, but not described, by William Bros., Ceylon.

Kapat Bhanga. Listed, but not described, by William Bros., Ceylon.

Kauai Chutney, Hawaii. Also known as the Java, etc. It is improperly called a chutneym as it lacks the characteristics of that group. (See explanatory note under *Lemon Chutney*). Size large; form thick at the shoulders and almost round, while it tapers rapidly to a point at the stigmatic end; color varying from lemon yellow to saffron where exposed and when thoroughly ripe more or less dotted with red spots which have a gray center where the epidermis is ruptured; peeling qualities fair; flesh rather brighter yellow than is found in the No. 9; texture exceedingly good for a seedling, there being no fiber except close to the seed; flavor very good; a distinguishing characteristic of this form is the large size of the leaves.—Higgins.

Kavasji Patel, India. (Sometimes spelled *Cowasjee Patel*).

Weight twenty-one ounces; size five and one-fourth by three and three-fourths inches. Gathered green, with white pulp, for cooking. A fine large cooking sort. Both shoulders falling; beak prominent.—Woodrow.

Khajya, India. Sparse bearer; medium size; first quality; color yellow and red; stone small; tree tender; ripens late; keeps well; medium free grower; fair in flavor.—Hartless, Saharanpur.

Khapariah, India. Introduced under S. P. I. Nos. 9510 and 10641. (Also spelled *Khaparia* and *Kahpariah*).

Medium size; medium sparse bearer; third quality; color green and yellow; stone small; tree hardy; ripens medium; keeps well; free grower; fair in flavor.—Hartless, Saharanpur.

Khatkia, India. A longish, hooked, pointed fruit. Color yellow, shaded red.—Saharanpur.

Weight seven ounces; size four and one-half by two and five-eighths inches; skin doubtful; pulp sweet and piquant, but stringy; both shoulders low; beak depressed. A popular mango, to be sucked.—Woodrow.

Khetubasek. Listed, but not described, by William Bros., Ceylon.

Kheershapottee, India. Probably synonymous with *Khirsapati*.

Khijura Goorka. Very sweet.—William Bros., Ceylon.

Khirpooli. Listed, but not described, by William Bros., Ceylon.

Khirsapati, India. Now under trial in Florida. Listed, but not described, by William Bros., Ceylon.

Khoosi, India. Weight eight ounces; size three and three-fourths by three and one-eighth inches; skin dull red and yellow, blotchy; pulp very fine, creamy, dark yellow, but puffy. A very fine fruit, but with an unattractive color.—Woodrow.

Khrishnakali. Listed, but not described, by William Bros., Ceylon.

Kissen Bhoga (or Kissenbhog.) Now under trial in Florida. Listed, but not described, by William Bros., Ceylon.

Kistapai, India. Introduced under S. P. I. Nos. 9536 and 10656. (Sometimes spelled *Kistaphal.*) Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A large fruit. Flesh highly colored and of good flavor.—Saharanpur.

Sparse bearer; medium size; second quality; color yellow and red; stone small; tree tender; ripens late; keeps well; medium free grower; good.—Hartless, Saharanpur.

Krishna Bhog, India. Introduced under S. P. I. 9532. (Sometimes spelled *Khrishna Bhog*).

Sparse bearer; large size; second quality; color yellow and green; stone medium size; tree tender; ripens late; keeps well; slow grower; good.—Hartless, Saharanpur.

Kumrajali. Listed, but not described, by William Bros., Ceylon.

KUMUKHT, India. Described by Maries, has a rough skin, a large beak, eight ounces in weight, and has a fine flavor.—Woodrow.

KUTNA, India. A favorite variety.—Saharanpur.

Sparse bearer; medium size; second quality; color yellow; stone medium size; tree hardy; ripens late; keeps well; slow grower; fair.—Hartless, Saharanpur.

LAMBA BHADRA, India. Introduced under S. P. I. No. 9537. Fruited in Florida.

Sparse bearer; fruit large; first quality; color green and yellow; stone large; tree hardy; ripens mid season; keeps well; free grower; nicely flavored.—Hartless, Saharanpur.

Fruited in Florida for first time in 1911, and said by Reasoner to be so inferior as to be worthless.

LANGRA, India. Introduced under S. P. I. No. 9511. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight six and one-half ounces; size three and five-eighths by two and five-eighths inches; skin very thin, green, with a yellowish tinge when ripe; pulp creamy, and of delicious flavor; no fiber and small stone; both shoulders falling; beak very small. This is *Maldah,* described in Botanical Magazine, t. 4510.—Woodrow.

Prolific bearer; medium sized fruit; first quality; color green; stone small; tree medium hardy; ripens mid season; does not keep well; free grower; fine flavored.—Hartless, Saharanpur.

LANGRA BENARSI, India. One of our introductions from India which bore in 1910 for the first time. Promises to be very prolific and is a strong grower. The fruit is the largest we have ever seen, weighing up to three pounds one ounce each. Very little fiber, flavor rich and spicy. Fruit is yellow or greenish when ripe.—Reasoner, Florida.

LANGRA HARDOI, India. Introduced under S. P. I. Nos. 9538 and 10651. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A thin seeded variety of good flavor, ripens late. Medium sized fruit, pale yellow, flesh very rich.—Saharanpur.

Prolific bearer; medium size; second quality; green in color; stone medium size; tree hardy; ripens medium; keeps well; free grower; similar to Langra, but more stringy.—Hartless, Saharanpur.

LANGRA LARGE, India. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; medium size; second quality; green in color; stone medium size; tree hardy; ripens medium; keeps well; free grower; similar to Langra, but more stringy.—Hartless, Saharanpur.

LARGO, Porto Rico. A form common on the south side of the island and at Mayaguez. Long, nearly straight, stem not depressed, green in color. The flesh is very firm, moderately thick, and with very few fibers. At Yauco slightly shorter specimens were called *"Mangotina,"* a name used very loosely in all markets, this form selling for ten for one cent. The flavor is fine, though the taste of turpentine is pronounced, and to those who do not object to this feature it will appeal as one of the best of the Porto Rican forms.—Collins.

LATANIA. A creeping variety.—William Bros., Ceylon.

LATE MULGARRI, India. Fruited in Florida. Fruit small to medium, yellow, highly flavored, usually late to ripen, contains but little fiber. Prolific.—Reasoner, Florida.

LATHROP. Introduced by the Division of Seed and Plant Introduction, U. S. Dept. of Agriculture, and fruited in Florida for the first time in 1911. Said by Reasoner to be so inferior as to be worthless.

LEMON CHUTNEY, Hawaii. Size large for this class; color, a light lemon yellow, dotted with lighter yellow after the manner of the chutneys; peeling qualities good; texture good; flavor good; seed medium size.—Higgins.

Explanatory Note: The term chutney should be used as the name of a class rather than of a variety, and does not signify a mango used chiefly for the manufacture of chutney, as might be supposed. The flavor of the members of this class is characteristic, and though not so sweet as most of the other varieties, it is nevertheless very agreeable and more esteemed by many than any of the sweeter kinds. There is a delightful acidity and spicy character, with a pleasant aroma and usually a characteristic odor in all parts of the plant. The difference between the forms is sometimes very slight, but in other cases it is well marked. They are sometimes separated into so-called acid chutneys and sweet chutneys, but it is quite probable that most of the forms classed as sweet chutneys are really the result of crosses between acid chutneys and some of the sweet mangos.—Higgins.

Lerrua, India. A variety described by Maries, chiefly valued for its fine coloring, orange and red and green in stripes and blotches.—Woodrow.

Long Manila, Hawaii. Size medium to large; form long, narrow; color light yellow; texture good; flavor very good; seed thin, flat. It appears to be the same as that known in Porto Rico under the name Manila.

It will be observed that the term Manila is applied to several varieties grown in these islands, and means very little except that the original of the variety is supposed to have come from Manila.—Higgins.

Lyon, Philippines. Introduced under S. P. I. Nos. 27835 to 27838.

Grown from S. P. I. No. 25940, which was introduced under the class name of Pahutan.—Bureau of Plant Industry. See *Pahutan*.

Madras, India. Now under trial in Florida. Prolific bearer; small size; second quality; color greenish red; stone medium; not very hardy in the United Provinces; ripens medium; keeps well; free grower; fairly good.—Hartless, Saharanpur.

Malda, India. (Syn. *Jalibandha*). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Prolific bearer; large size; third quality; yellowish green in color; stone medium; very hardy; early ripening; does not keep well; medium free grower; very large; insipid in taste.—Hartless, Saharanpur.

Synonymous with *Langra* (which see).—Woodrow.

Maharajah. Introduced under S. P. I. No. 27848. Now under trial in Florida.

Fruit roundish oblique, flattened, four and one-eighth by three and three-sixteenths by two and seven-eighths; cavity shallow, with a distinct suture extending two inches from stem; beak medium, about one inch from end of fruit; surface moderately smooth, some fine undulations; color, greenish yellow, shading to rich yellow; dots very numerous, yellow; skin thick, tenacious; flesh rich yellow, tender, but very fibrous; flavor sweet, pleasant quality, if fiber was not so abundant would be good; seed flat, oval, covered with a dense coat of fiber; medium size, three by one and eleven-sixteenths by seven-eighths inch.—W. A. Taylor.

Maison Rouge, Mauritius. Introduced under S. P. I. No. 27928.

Malcoa. Listed, but not described, by William Bros., Ceylon.

Maliabad. Listed, but not described, by William Bros., Ceylon.

Maller, India. Introduced under S. P. I. No. 23747. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Maneckjee Rustomjee. Listed, but not described, by William Bros., Ceylon.

Mangalore, India. Introduced under S. P. I. No. 27849. Now under trial in Florida.

Fruit oblong, flattened, four and one-sixteenth by three and five-eighths by two and five-eighths inches; cavity shallow, small furrows without suture; stem very slender, with bracts; beak small, one-sixteenth inch above general surface, seven-eighths inch from end center; surface moderately smooth; color yellow, with marblings of

green; dots numerous, yellow; skin thick, tenacious; flesh deep yellow, tender except for fiber, juicy; flavor mild subacid; quality good; seed flat, oval, three and one-half by two and one-eighth by seven-eighths inch.—W. A. Taylor.

MANGO, Porto Rico. A large, rather straight form, with a very square base, somewhat resembling Largo, but slightly more symmetrical and thicker. Large quantities were seen in the San Juan market on June 22, a month later none were to be found. The flesh was fairly thick and of good quality.

This name may possibly be a contraction of *mangon*, which would not be at all inapplicable, as this is one of the largest Porto Rican forms. Stahl gives *mango* as the common name of *Mangifera indica* in Porto Rico.—Collins.

MANGOSTEEN, Hawaii. Improperly so-called. Size small; form rounded, unlike most mangos; color green with a dull red on the exposed side before ripening, but turning to a very beautiful bright red, thus making it one of the most ornamental of the mangos; flavor poor; seed very large. It is very subject to mango blight.—Higgins.

MANGOTINA, Porto Rico. A very small yellow form, with one side red. Similar to Mayaguez, seen at San Juan, but longer, with rounder base and stigmatic point nearer the apex.—Collins.

MANILA of Mexico. A Mexican race, almost entirely free from fiber, and of mild, pleasant flavor. The skin is uniformly light yellow and thin; the flesh is also light colored and firm. The seed is very thin and small in proportion to the amount of flesh.

This is really a high grade mango, not unlike the *Mulgoba* in flavor. Its shipping qualities have not been tested, but perfectly ripe fruits purchased in Mexican markets kept in good condition for several days. This mango was very popular in the City of Mexico about the end of June. It was sold in all the markets and hawked on the streets, the price usually being four cents apiece Mexican. The uniformity of the fruit as it appeared in different markets, taken with the absence of asexual methods of propagation in Mexico, would argue that it is a form that comes true from seed.

The name of this race suggests that it came from the Philippine Islands, and indeed it is not impossible that it was brought to Mexico from those islands by one of the Spanish galleons that during the seventeenth century plied regularly between the Philippines and Mexico.

A form resembling this in Guam is there commonly supposed to have come from the Philippines, but as ships only touched at Guam on the return voyage from Mexico, the fruit must have reached Guam by way of America, and would naturally have become established in both countries. Possibly a further confirmation is to be found in the occurrence of the same or a very similar form in Cuba, known as the Philippine mango.—Collins.

MANILA of Hawaii. This is sometimes spoken of as the Double-Pointed Manila. Size very large; form roundish with stigmatic point giving rise to descriptive name; color light green tinged with yellow, approaching orange yellow when fully ripe; peeling qualities good; texture very good, with no fibers except close to the seed; flavor good, sweet, juicy; color of flesh yellow orange; seed thin.—Higgins.

MARTIN, French West Indies. Beautiful yellow, sometimes almost rose colored, slight turpentine flavor.—Jumelle.

MAYAGUEZ, Porto Rico. A small yellow form, with comparatively large seed, but with good flavor, soft flesh, and few fibers. This form, for sale in the San Juan markets, is considered one of the finest. It has very little of the turpentine taste, but its flavor did not appear to be better than that of several others, while its small size and thin flesh make it seem on the whole inferior. In shape it is asymmetrical, with depressed stem. The color in the early part of the season is a uniform yellow, later many specimens were seen with one side red. Collins.

MAZAGON, India. Introduced under S. P. I. No. 7042. Now under trial in Florida.

Mekongensis. Now under trial in Florida.

Melocoton, Porto Rico. A small yellow and red form seen at Yauco, said to have come from a grafted stock brought from Martinique. Base very square, stem slightly depressed, skin thin, meat with few fibers, mild in flavor.—Collins.

Moanalua Long Red, Hawaii. This is in all probability a cross between some form of chutney and the sweet mango. The seeds which produced this tree and several others of the more normal type of chutney in the same locality are said to have come from a single parent tree on the island of Maui. The variety is so named because the tree producing this rather peculiar form is located at the Moanalua gardens. Size large; form long and pointed; color before ripening green on the unexposed surface, with a dull red on the exposed side, which brightens to a red orange in ripening, a rather unusual color for a chutney; peeling qualities fair; texture fair; flavor lacking somewhat in the character of the chutneys; color of flesh rather dark; seed medium.—Higgins.

See explanatory note under *Lemon Chutney*.

Mohanbhoga. Listed, but not described, by William Bros., Ceylon.

Mohan Thacoor. Listed, but not described, by William Bros., Ceylon.

Moradabadi Amin, India. Introduced under S. P. I. No. 9541.

Flavor superior.—Saharanpur.

Moria, India. Weight eight ounces; size three and five-eighths by three and one-eighth inches; skin yellowish green, reddish on shoulder; pulp very sweet, slightly fibrous; left shoulder broad, gently rising, right shoulder falling; beak small, sharp. A good keeping sort.—Woodrow.

Mulgoba, India. Introduced in 1889 by Division of Pomology, U. S. Dept. of Agriculture. First fruited in Florida in 1898, being the first of the Indian varieties to fruit in this country. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight twenty ounces; size five by four and seven-eighths inches; skin yellow and green, blotched; pulp pale yellow, no fiber, flavor piquant and sweet; stalk scar very prominent; left shoulder level, right shoulder falling; beak large, sharp. Plants of this variety were sent to Florida in 1889 by the writer and have given much satisfaction.—Woodrow.

Form roundish, oblique, reniform; size large, weighing from three-fourths pound to one pound; surface smooth and undulating; color yellow, beautifully blushed with red and faintly dotted with numerous brown dots; skin thin, tough, tenacious; seed reniform, oval, rather large; fiber scanty, fine, and tender; flesh rich apricot yellow, very tender, melting and juicy, sweet, rich, fragrant; quality very good.

The *Mulgoba* surpasses in flavor and quality the seedlings previously grown, but its most distinctly marked features of superiority are the tenderness of the flesh and absence of objectionable fiber and strong turpentine flavor common to most of the seedlings grown in this country. The tree is a strong symmetrical grower, and appears to be abundantly productive.—1901 Yearbook U. S. Dept. of Agriculture.

Mullgoa, India. Introduced under S. P. I. No. 7102. Fruited in Florida.

Fruit large (twelve to sixteen ounces), almost round, fiberless, and of good flavor. —Reasoner, Florida.

Mussarata, India. Weight fifteen ounces; size four and one-fourth by three and three-eighths inches; skin, exposed side yellow, shaded side green; pulp cream colored, fine rich flavor; left shoulder high, right shoulder rising slightly; beak none.—Woodrow.

Najibabadi Amin, India. Introduced under S. P. I. No. 9542. Now under trial in Florida.

Flavor superior.—Saharanpur.

Sparse bearer; small fruit; second quality; color yellowish red; stone medium; tree hardy; ripens mid season; keeps well; free grower; fairly good.—Hartless, Saharanpur.

NAJI HAHADI AMIN, India. Introduced under S. P. I. No. 10668. (Same as *Najibabadi Amin*.)

A medium sized, dark green fruit, ripens late—Saharanpur.

NARALYA, India. Weight ten and one-half ounces; size four by three and one-fourth inches; pulp pale yellow, slightly fibrous; flavor piquant; left shoulder very high and broad, right shoulder broad, falling; beak very small.—Woodrow.

NARAYAN ROPRA, India. Weight ten ounces; size three and three-fourths by three and five-eighths inches; skin green with yellow shading near the stalk; pulp deep yellow, of fine flavor, but fibrous; shoulders both falling, or level; beak small.—Woodrow.

NASPATI, India. A variety with a pear shaped fruit. Not a good bearer.—Saharanpur.

Sparse bearer; medium size; first quality; pale yellow in color; stone small; tree hardy; ripens late; keeps well; slow grower; good flavored.—Hartless, Saharanpur.

NAYAB, India. Sparse bearer; small size; second quality; brown in color; stone medium; tree hardy; ripens medium; keeps well; slow grower; good kind.—Hartless, Saharanpur.

NAWAB BHOGA. Listed, but not described, by William Bros., Ceylon.

NAWSHARWANI, India. Weight about sixteen ounces; size four and seven-eighths by four and one-eighth inches; both shoulders high; beak sharp.—Woodrow.

NECTARINE, Hawaii. Locally known under this name. Size small; form short, rounded, rather heaviest on the dorsal side and about equal in length and breadth; color dark, dull green, acquiring slight yellow tinge in ripening; flavor peculiar, attractive, having a slight biting taste, supposed by some to resemble the nectarine. The flesh is characteristic, being the most highly colored the writer has seen in any variety of mango. Higgins.

NOWSHARI, India. Weight about twenty ounces; size four and seven-eighths by four and one-eighth inches; skin shaded yellow on shoulders, darker downward. A fine large mango, of which definite information is wanting.—Woodrow.

NUCKA, India. Introduced under S. P. I. Nos. 9544 and 10659. Now under trial in Florida.

A long, hooked, pointed fruit, slightly fibrous, but flavor good.—Saharanpur.

Sparse bearer; fruit small; second quality; color brown; medium size stone; tree hardy; keeps well; slow grower; good.—Hartless, Saharanpur.

No. 5, Hawaii. Locally known under this name. This was among the introductions of Mr. Marsden. It very closely resembles the common Hawaiian Sweet mango, but is rather broader at stigmatic end. Color, flavor, peeling qualities and texture are also much like those of the latter.—Higgins.

No. 7, Hawaii. Locally known under this name. This variety was introduced, together with No. 9 and others, by Mr. Marsden. Size rather small, form exceedingly variable, great differences being noticeable on the same tree; color a dull, somewhat dingy shade of yellow orange, overlaid with a beautiful orange red on the exposed side; peeling qualities poor; texture inclined to be fibrous; flavor peculiar and not very pleasing; flesh dark; seed of medium size.—Higgins.

No. 9, Hawaii. This variety, now quite common in Hawaii, was introduced about twenty years ago under this name by Mr. Joseph Marsden, who at the same time added several other forms to the local collection. Form resembling the letter S, stem prominent; size from three and one-half to four and one-half inches long, and two and three-eighths to two and seven-eighths inches broad, and from two to two and one-half inches thick; color before fruit is mature, green, turning to pale yellow when ripe, with a slight blush of pink on the upper end of exposed side; peeling qualities very good; texture variable but most specimens rather fibrous; flavor sweet but watery; flesh light yellow; seed small; tree an abundant bearer. The fruit appears to be quite resistant to the attacks of the mango blight.—Higgins.

No. 11, Mauritius. This variety, the original stock of which was among the first mangos introduced into Jamaica by Captain Marshall, in 1782, is still the most popular variety in the island. It is a fine fruit, though somewhat stringy, and is said to come true to seed. Mr. Hart identifies this variety with the *Reine Amelie* of Martinique. As Martinique received a large part of its early introduced plants from Mauritius, the source of this variety in Jamaica, this identification doubtless means identity of origin, and the fact that these distinct strains are still identifiable would argue great constancy for this variety. Budded stock of this variety is also grown in Florida.—Collins.

A variety from Jamaica, but originally from the East. A spicy-flavored sort, with almost unobjectionable fiber (very fine), and of good, large size. The shape is slightly oblong; round, not flat, and in color usually a yellow or green, but we have one tree, out of nearly three dozen bearing specimens, which has a highly colored red cheek, rendering it a valuable market sort. (See *Red No. 11*).—Reasoner, Florida.

Ogee, India. Weight thirty-one ounces; size seven and one-eighth by four and one-eighth inches; skin golden; pulp sweet, free from turpentine, but not luscious; stone comparatively small, left shoulder falling gently, right shoulder falling abruptly; beak small but distinct.—Woodrow.

Paheri, India. Introduced under S. P. I. No. 8730. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Fruited in Florida in 1910 for the first time. One of the finest sorts grown in India. General form is roundish, about three and five-eighths by three and three-eighths inches. Skin thick, yellow and green when ripe, touched with garnet red on sunny side, very attractive. Flesh yellow, tender and juicy, very aromatic. Of high quality. —Reasoner, Florida.

From India. Size medium; color yellow, blushed with red and pink on side exposed to light; shape nearly round, slightly flattened and obliquely impressed on one side, with a point protusion at blossom point; skin medium thin, of firm substance; flesh rich golden yellow color, fine grain, tender; flavor rich and melting, highly aromatic and spicy. The fruits can be easily separated in halves without leaving any fiber in the pulp, which can be eaten from the fruit with a spoon.—Cellon, Florida.

Pahutan, Philippines. Introduced under S. P. I. No. 25940. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

From my viewpoint this is the best, *not* horticulturally, other than being a vigorous grower, early fruiter, and enormously prolific. Its very serious defects,—small size, scanty flesh, and excessively large seed,—are from my point of view fully offset by a smoothness, sweetness, juicyness, and flavor unapproached by any other. I have eaten the famous Alphonso mango in Calcutta and do not consider it ace high with Pahutan. Pahutan further has a very thick rind. This, while still further diminishing its scanty flesh, probably adds to its shipping qualities.—Lyon.

Pairi, India. Probably a synonym for *Pyrie,* which see.

Pakria, India. Introduced under S. P. I. No. 8444.

Weight seven ounces; size four by two and five-eighths inches; skin pale yellow; pulp pale yellow, of delicious flavor without fiber; both shoulders falling; beak none. The leaves are of medium size, pale green, and acute at the base.—Woodrow.

Panch Sera, India. Very large fruit.—William Bros., Ceylon.

Pandria, India. Weight nine ounces; size three and one-fourth by three and one-eighth inches; skin greenish yellow; pulp sweet but wooly; both shoulders falling; beak none.—Woodrow.

Parnasse, French West Indies. Oval, flattened; light green skin; fiberless, delicious.—Jumelle.

PARROT, Ceylon. Medium sized, oblong fruit; with a distinct beak. Piquant and pleasant flavor.—Macmillan.

Fairly prolific; fruit medium to small, of second quality; skin dark green; seed of medium size; ripens late and is a fair keeper. The tree is a free grower and is hardy. This variety has a slight turpentine flavor and is not very common.—Dr. Drieberg, Ceylon.

PEACH, Hawaii. This variety has some local reputation under this name. The original tree of the variety, at least in these islands, is in the Henry Davis homestead in Honolulu. Size medium; form resembling the Samoan; color before ripening bright green overlaid with dull red on exposed side, the red brightening and the green becoming yellow during the ripening process; peeling qualities fair; texture good, quite free from fiber except near the seed; flavor very good, abounding in sweet juice; color of flesh almost as light as that of No. 9; seed long and of medium thickness.—Higgins.

PERE LOUIS, French West Indies. Introduced under S. P. I. No. 3707. Fruited in Florida.

It is not large, weighing but seven or eight ounces, but it has a very distinct and delicate flavor, is almost absolutely free from fiber, and the meat is soft and custardy and can be eaten with a teaspoon. In this Mr. Gale has a prize, as it is one of the most delicate, highly flavored and aromatic of the family of mangos, and is a valuable addition to the varieties being grown in Florida.—The Homeseeker.

PERRINE, Florida. The fruit is very fragrant when ripe; size medium to large; plump oblong, obliquely impressed on one side; color greenish yellow, with greater portion of the surface a bright carmine fading to delicate pink tints; skin thin but firm; flesh pale yellow color, fine grained, tender, melting and juicy; flavor very delicately aromatic; seed very small and thin, fiber fine and short, only on edges of seed. Tree a good grower and prolific bearer.—Cellon, Florida.

PETERPASAND, India. Introduced under S. P. I. No. 7101.

PETERS, West Indies. (Syn. *Peters No. 1*, S. P. I. No. 3706). Fruited in Florida.

Form roundish oblong, heavily shouldered at base and plump at apex; size medium; stem rather stout, inserted in a small, shallow cavity; apex swollen, with a broad, strong beak an inch or more from the extremity of the fruit; surface moderately smooth; color greenish yellow, blushed, striped and splashed with light and dark red; dots numerous, yellow; bloom bluish white; skin moderately thick, tenacious; seed small, oblong, thin, adhering tenaciously; flesh thick, yellow, meaty, tender and juicy, with but little fiber; flavor sweet, aromatic, rich; quality good to very good; season July 15 to August 1 in Manatee Co., Florida.

The tree is described as of broad, spreading habit.—1908 Yearbook U. S. Dept. of Agriculture.

PHILLIPS No. 9, Hawaii. This is the form of the No. 9 distinct from the ordinary form and from that described as Herbert No. 9. Size smaller than either of the other varieties to which it is related; form decidedly like No. 9, but with the stem end drawn out into a protuberance from one-fourth to one-half inch long; color similar on the unexposed side to No. 9, on the exposed side a dull red before the fruit is ripe, turning in ripening to a tint of orange red; peeling qualities excellent; texture fair; flavor fully equal, if not superior to its allied forms.—Higgins.

PIA POSHA, India. Weight fourteen ounces; size five and three-eighths by three and one-eighth inches; skin rich cream colored, suffused pale crimson on the exposed side; pulp pale yellow, very sweet, and agreeably flavored but stringy; both shoulders falling equally; beak large. A very showy fruit with a delightful fragrance.—Woodrow.

PICO, Philippines. Introduced under S. P. I. No. 24170. Now under trial in Florida.

A variety of merit. It comes true from seed and by that method has been reproduced in that country (Philippines) for generations.—MacIntyre.

Pina, Porto Rico. A short, thick form found in the San Juan market before the middle of June, green, slightly asymmetrical, with rather oblique base, stem depressed. The meat is thick, of good texture and flavor.—Collins.

Pineapple, Hawaii. A tree producing fruit known by this name locally is found on the Punchbowl slopes near Alapai street, Honolulu. It has received this name because of a resemblance in flavor, fancied or otherwise, to that of the pineapple. Size small; form resembling the Davis No. 11; color yellow splashed with red about the stem end; peeling qualities excellent; texture fair; flavor very fine; color of flesh light, approaching orange yellow; seed large. This is a pretty mango and well suited for home use, but its large seed and its texture are against it.—Higgins.

Pirie, India. Introduced under S. P. I. No. 8421. (Syn. *Pyrie*).

A green, pointed shaped variety from the Cooper estate at Goregon. Said by the owner, an inspector in the Bombay markets, to be, next to the Alphonse, the best of the Bombay mangos. The seed is larger than that of Alphonse and the flavor excellent. Has the undesirable quality of being a poor keeper, losing its flavor quickly after ripe.—Fairchild.

Pitu, India. Weight five and one-half ounces; size three and five-eighths by two and five-eighths inches; skin green and golden.—Woodrow.

Pointed Chutney, Hawaii. (See explanatory note under *Lemon Chutney*). Size medium; form rather long, tapering to a sharp point; color yellow; peeling qualities good; texture fair, many specimens found with peculiar white lumps in the flesh, which, however, are not thought to be normal but due to the work of mealy bugs in large numbers on the exterior of the fruit throughout its time of growth; flavor decidedly acid; color of flesh very light just beneath the skin, ripening from the center outward with the outer layer quite firm, while the interior has become softened, a character found in many of the chutneys; seed of medium size, resembling the outline of the fruit; tree a vigorous grower and heavy cropper.—Higgins.

Pootoo. Listed, but not described, by William Bros., Ceylon.

Punia, India. Introduced under S. P. I. No. 10655. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A medium sized, stringy kind. Flavor very good.—Saharanpur.

Prolific bearer; small size; first quality; color reddish yellow; stone small; tree tender; ripens late; keeps well; slow grower; lemon scented.—Hartless, Saharanpur.

Pyarekhas. Listed, but not described, by William Bros., Ceylon.

Pyasee, India. Introduced under S. P. I. Nos. 9545 and 10663.

A medium sized fruit of subacid flavor. Good.—Saharanpur.

Sparse bearer; medium sized; third quality; color yellowish brown; stone medium; tree tender; ripens mid season; keeps well; medium grower; somewhat sour at times.—Hartless, Saharanpur.

Pyrie, India. Weight eight ounces; size three and three-fourths by three inches; skin varying from red on the shoulder to pale yellow at the beak, very brightly colored; pulp soft, creamy, of delicious delicate flavor; stalk scar prominent; beak large. A first class sort.—Woodrow.

Ragu, India. Size five and seven-eighths by two and one-eighth inches; skin yellow; pulp deep yellow; flavor distinct and agreeable; no fiber; both shoulders falling; large depression in place of beak.—Woodrow.

Rainbow, Hawaii. Known to a limited number of people under this name, the one tree of the variety known to the writer being in the Henry Davis homestead at Punahou, Honolulu. Size medium; form resembling that of the so-called French or Wine mango; color light green on the unexposed side before ripening, the exposed side being overlaid with dull red which brightens in ripening to orange red in dots or stripes, much

brighter red than in the French; peeling qualities good; texture fair; flesh light yellow; flavor good, resembling No. 7.—Higgins.

RAJIA, India. Weight seven ounces; size three and one-eighth by two and one-half inches; skin yellowish green, tinged red on shoulder; pulp deep yellow, of rich sweet flavor, and no fiber; left shoulder level, right shoulder falling; beak none.—Woodrow.

RAJPURY, India. Introduced under S. P. I. No. 7105. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry. (Also spelled *Rajpuri, Rajabury,* and *Rajapurri*).

Average size about ten ounces in weight, a trifle elongated, flavor rich and buttery. Both flavor and aroma distinct from any other mango; very attractive and very prolific.—Reasoner, Florida.

This is a fruit averaging from eleven to twelve ounces, and while it is practically free from fiber and of a delicate texture and flavor, its remarkable characteristic is its perfume, which is entirely different from any other mango yet grown in this section. This perfume, fascinating and delicate as it is, is hard to describe, and this mango, like many others that are being propagated here, is bound to become of great value, as it promises to be a prolific bearer and a great favorite.—The Homeseeker.

It weighs from seven to fourteen ounces, seventy-five per cent. of all the fruit weighing from ten to eleven ounces, and is more nearly globular in shape than any other of our mangos. It has a fine aroma and flavor, which are distinct and peculiar to itself, preferred by many to Mulgoba or Alphonse. Yellow, with delicate pink cheek where exposed to the sun. As nearly spherical in shape as a mango ever is.—Beach, Florida.

RASPBURY, India. Introduced under S. P. I. No. 7106.

RASPURI. Listed, but not described, by William Bros., Ceylon.

RAYNAUD, French West Indies. Native of the Indian archipelago. Small, round, light colored outside, flesh whitish and aromatic.—Jumelle.

REDONDO, Porto Rico. A large, thick-meated form, common in the Ponce market. In form it is quite symmetrical, with a decidedly depressed stem. In color it varies from green to red, the difference being in some instances so marked as to suggest a distinct type. The color seemed the only difference, however, and the market people insisted that the green and the red might come from the same tree. The flesh is very juicy, moderately free from fiber, and of a very good flavor.—Collins.

RED No. 11, West Indies. A West Indian descendant of a fine Indian sort, having high color, but is small and somewhat fibrous.—Reasoner, Florida.

REINE AMELIE, French West Indies. Skin very thin, slightly spotted, easily separated from the pulp.—Jumelle.

ROBERTS, Florida. This is a descendant from No. 11 and has been propagated by budding to some extent. It is distinctly to be preferred to the usual run of No. 11's, being highly colored and having less fiber.—Rolfs.

ROMANI, India. Introduced under S. P. I. No. 10658. A medium sized fruit, subacid, of very fine flavor.—Saharanpur.

ROOS, India. Introduced under S. P. I. No. 7043.

ROSA, Porto Rico. A nearly spherical form, seen at Yauco, yellow in color, with one side a beautiful red. The skin is very thin, the meat comparatively free from fiber, very mild and pleasant, without a trace of turpentine flavor.—Collins.

RUNTRA. Listed, but not described, by William Bros., Ceylon.

RUPEE, Ceylon. Introduced under S. P. I. No. 8412. The largest fruited mango grown in Ceylon. It is called the *Rupee,* or two shilling mango, because of the price paid for a single fruit. Its origin is unknown. It is very large, sometimes five inches long, nearly globular, light green in color when ripe. A shy bearer. Skin tender and easily

bruised, rendering the fruit a poor shipper. Flesh is golden yellow. Seed small in proportion to size of fruit. A rare variety even in Ceylon. Flesh free from stringiness and flavor delicious, but only when perfectly ripened on the tree. The tree is not very robust, and Dr. Drieberg does not recommend the variety for general planting. —Fairchild.

Very large and somewhat round, pulp luscious and free from fiber; similar to *Inerma* of Bombay.—Macmillan.

This is also called the *Two Shilling*. It is a sparse bearer; fruit the largest of the local (Ceylon) varieties, of first quality; skin pale green; seed small compared to size of fruit; ripens late and is not a good keeper. The tree is not a free grower and is tender. This variety is scarce and expensive. Requires very careful ripening. —Dr. Drieberg.

Russet, Hawaii. Introduced under S. P. I. No. 12930.

Ryotya, India. Weight eight ounces; size three and three-eighths by two and three-fourths inches; skin bright crimson on exposed side, creamy on shaded side; pulp creamy yellow, of extra fine quality, and no fiber; both shoulders falling equally; no beak; exactly obovate. A really fine fruit, handsome and prolific.—Woodrow.

Sa Pachand. Listed, but not described, by William Bros., Ceylon.

Safaida. Listed, but not described, by William Bros., Ceylon.

Safeda. Listed, but not described, by William Bros., Ceylon.

Saffron, Hawaii. Size medium; form rather short, resembling *Wooten Chutney;* peeling qualities fair; color rich saffron; texture good; flavor good. The original tree of this variety in the islands is a seedling growing at Kalihi. It is one of the most esteemed of the local seedlings.—Higgins.

Saharanpur No. 1. Listed, but not described, by Reasoner Bros., Florida.

Saint Aime, India. Weight fifteen ounces; size four by four inches; skin greenish yellow; pulp deep orange, of coarse grain but rich flavor; left shoulder high and broad, right shoulder low and broad; beak none.—Woodrow.

Salamar, India. Introduced under S. P. I. No. 9535. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Salgada, India. Weight twenty-four ounces; size five and one-fourth by four and one-half inches; skin greenish yellow on shoulder, shading downward to yellow; very sweet and agreeably flavored; right shoulder very high, left shoulder level, then descending.—Woodrow.

Salgadina, India. Weight seven ounces; size three and three-eighths by two and three-fourths inches; skin rich crimson, shading to yellow; pulp deep yellow; left shoulder level, right shoulder falling; beak none.—Woodrow.

Salibunda, India. Introduced under S. P. I. Nos. 9513 and 10642.

A distinct variety, a large fruit, subacid flavor, color greenish yellow.—Saharanpur.

Prolific bearer; small size; second quality; yellowish red; stone medium; tree hardy; ripens medium; keeps well; medium vigorous grower; good.—Hartless, Saharanpur.

Samar Chist, India. Introduced under S. P. I. No. 9534.

Samoan, Hawaii. So called by Mr. Allan Herbert, who introduced the seed from Samoa. Size medium; form oblong; color pale yellow with a bright tinge on the exposed cheek, occasionally striped; peeling qualities fair; texture good for a seedling, the fibers being very fine; flesh light yellow just under the rind, slightly darker within; flavor sweet, with abundant juice.—Higgins.

Sandersha, India. Fruited in Florida. (Synonyms *Sandershah, Sandershaw, Soondershah* S. P. I. No. 7108, and *Sundershah* S. P. I. No. 10665).

A long fruit, stringy, flavor peculiar and only liked by some people.—Saharanpur.

Prolific bearer; size small; third quality; color green; stone large; tree hardy; ripens mid season; does not keep well; free grower; fair.—Hartless, Saharanpur.

So far as known the latest to ripen. Fruit long, yellow, of the very largest size, sometimes weighing two pounds. Somewhat acid.—Reasoner, Florida.

Form long, compressed, and rather slender, tapering toward stem and terminating in a distinct curved beak at the apex; size very large, averaging around twenty ounces in weight, and occasionally attaining a weight of two pounds; stem stout, apex prominent, curved and beaked; surface smooth; color clear yellow, with faint pinkish blush in the sun; dots numerous, small, russeted; skin moderately thick; seed long, curved, thin, small in proportion to size of fruit and thickness of flesh; flesh rich reddish yellow, juicy and tender, almost entirely free from fiber; flavor sprightly and refreshing in the fresh state, though with rather less aroma than *Mulgoba*. Its higher acidity will doubtless render it more acceptable for serving in sliced form than are most of the mangos thus far obtainable in our markets. Season very late, ripening in the latter part of August at Miami, Florida.—1907 Yearbook U. S. Dept. of Agriculture.

SANDURIA, India. Introduced under S. P. I. Nos. 9547 and 10667. Now under trial in Florida.

A small long shaped fruit. Stringy but of fine flavor.—Saharanpur.

Prolific bearer; small size; second quality; color red; stone medium; ripens mid season; keeps well; medium grower; good.—Hartless, Saharanpur.

SANS-PAREILLE. French West Indies. Largest of all, but of mediocre quality.—Jumelle.

SARI. Listed, but not described, by William Bros., Ceylon.

SARIKHAS. Listed, but not described, by William Bros., Ceylon.

SEED-MANGO. Ceylon. A small oval fruit, with scanty juicy pulp of a distinct piquant flavor.—Macmillan.

SHAH-PASSAND, India. Is a much esteemed variety said to be the same as Malda, and two pounds in weight, and of irregular shape.—Woodrow.

SHARBATI BROWN, India. Introduced under S. P. I. No. 9548. Now under trial in Florida.

Prolific bearer; small size; second quality; color brown; stone medium; tree hardy; ripens early; keeps well; medium grower; good.—Hartless, Saharanpur.

SHARBATI BLACK, India. Introduced under S. P. I. Nos. 9547 and 10669. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Prolific bearer; small size; second quality; color black; stone medium; not hardy in United Provinces; ripens early; keeps well; medium grower; good. Hartless, Saharanpur.

SHENDRIA, India. Weight seven ounces; size four and one-eighth by two and three-sevenths inches; skin deep yellow, spotted and flushed with carmine; pulp very fine, creamy, and rich in flavor, with a few fibers near the skin; left shoulder rising slightly, right shoulder falling abruptly; beak none.—Woodrow.

SHRAWANI ALPHONSE, India. Weight fourteen ounces; size four and seven-eighths by three and three-fourths inches; skin yellow; pulp deep yellow of fine flavor; stone large; left shoulder very broad and rising slightly, right shoulder falling; beak marked by an abrupt contraction.—Woodrow.

SINGAPUR, India. Introduced under S. P. I. No. 9550. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A small fruited variety of Bombay mango, flavor excellent.—Saharanpur.

Sparse bearer; medium size; second quality; color yellow; stone medium; tree hardy; ripens medium; keeps well; slow grower; taste resembles a loquat.—Hartless, Saharanpur.

Fruited for the first time in 1911, and proved to be all that was claimed for it by our Indian correspondent. The skin is green and golden yellow, finely mottled, thick and strong, with a grayish-blue bloom, clean and free from spotting. The flavor

is distinct, rich and sweet, with characteristic true mango flavor. The fruits are remarkably uniform in shape, meaty, thick and solid, perfect, weighing from fourteen to twenty ounces each, and we judge will be a remarkably good shipper. The seed is medium and flat.—Reasoner, Florida.

Sitalohoga. Listed, but not described, by William Bros., Ceylon.

Society's. Listed, but not described, by William Bros., Ceylon.

Stalkart, India. Introduced under S. P. I. No. 9514. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A small fruited variety of Bombay mango, flavor excellent.—Saharanpur.

Prolific bearer; medium size; first quality; color yellowish red; stone medium; tree hardy; ripens early; keeps well; free grower; resembles the Bombay.—Hartless, Saharanpur.

Strawberry of India. Introduced under S. P. I. Nos. 9515 and 10643. Fruited in Florida.

Medium sized, with a strawberry flavor. A longish, hooked, pointed fruit. Flavor good.—Saharanpur.

Fruited in 1910 for first time. Fruit small, of delicious flavor. Contains some fiber. A medium strong grower.—Reasoner, Florida.

Sparse bearer; small size; second quality; color yellowish red; stone medium; tree tender; ripens medium; keeps well; free grower; strawberry flavored.—Hartless, Saharanpur.

Strawberry of Hawaii. Size large; form roundish, uniform; color before ripening very light green overlaid on exposed side with dull red, which brightens on ripening; flavor very good; flesh light in color; seed medium.—Higgins.

Sucretino, India. Weight twelve ounces; size four by three and one-fourth inches; skin slightly yellowish at top but deepening to green at base; pulp sweet, with an agreeable subacid flavor; both shoulders falling; beak, place slightly depressed.—Woodrow.

Sufaida No. 1, India. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Prolific bearer; size large; first quality; color green; stone large; tree tender; ripens late; keeps well; slow grower; very good flavored; flesh firm.—Hartless, Saharanpur.

Sufaida No. 2, India. Prolific bearer; size large; second quality; color green; stone large; tree tender; ripens late; keeps well; medium free grower; fairly good.—Hartless, Saharanpur.

Summer Apple, Hawaii. In size and form this closely resembles the Davis No. 11, but it is very unlike it in other respects. Color a very light green and yellow, slightly orange tinted on the exposed side, and dotted with orange red; texture fair; flavor very poor; color of flesh rather light; seed medium size.—Higgins.

Sunhara, India. Introduced under S. P. I. No. 9551.

Surkha, India. Introudced under S. P. I. Nos. 9552 and 10652. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A stringy kind, but of good flavor.—Saharanpur.

Prolific bearer; medium size; first quality; yellowish red; stone medium; tree hardy; ripens late; keeps well; moderate grower; good.—Hartless, Saharanpur.

Surkhya, India. Weight four ounces; size three and one-eighth by two and three-eighths inches; skin rich creamy yellow, with crimson speckled shoulders; pulp pale cream colored, not fibrous, but of cloying flavor; left shoulder rising, right shoulder falling abruptly; beak none. A very showy fruit produced in great abundance.—Woodrow.

Tamancha, India. Introduced under S. P. I. Nos. 9553 and 10653.

A large fruit, greenish yellow, flavor good.—Saharanpur.

Sparse bearer; size small; second quality; color yellowish red; stone medium; tree tender; keeps well; ripens medium; free grower; sweet.—Hartless, Saharanpur.

THURSTON, Ceylon. Introduced under S. P. I. No. 8413.

Fruit is of medium size, short, and somewhat globular. The stone is of medium size and the skin is dark green when ripe. It ripens well off the tree. It is a vigorous grower, has a sweet flavor, and according to Dr. Drieberg is acid when not fully ripe. The flesh is greenish in color near the skin and slightly fibrous.—Fairchild.

TOASHAIK. Listed, but not described, by William Bros., Ceylon.

TOTAPARI, India. (Synonym *Totafari*). Introduced under S. P. I. No. 8732. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Skin very smooth, altogether yellow, moderately tough, pulp concolorous with skin. Slightly fibrous, flavor excellent. It measures four and seven-eighths by two and seven-eighths inches. Both shoulders fall equally, beak small but distinct (Bhide).—Woodrow.

A good midseason sort, resembling Sandersha, but only about half the size. Bears when very small.—Reasoner, Florida.

This has proven to be a good fruit. It is about the size of *Bennet*, but has not the same aroma or flavor, still it is very desirable and a valuable acquisition. Weight eight to ten ounces. Rather long and pointed at blossom end, much like *Sundersha* on a smaller scale. A free bearer.—Beach, Florida.

VANILLA, Hawaii. Size medium to large; form approaching roundness, with the stigmatic point more or less prominent; color quite uniform when ripe, passing through shades of yellow to those of orange yellow when ripening; peeling qualities good; texture fair to good; flavor rather too pronounced, with a slight bitter principle close to the seed; color of flesh orange; seed medium to large.—Higgins.

WALNUT, Hawaii. Size small to very small; some specimens being not much larger than a walnut; form rounded, but not full on the stigmatic side, the stigmatic point being almost obliterated; color a shade of yellow on the unexposed side, the exposed side blushed with red and orange at the stem end; peeling qualities fair; flavor fair; texture fair; seed large. It is valuable chiefly as a curiosity.—Higgins.

WHITE ALPHONSE (or *Safeda Alfoos*), India. Introduced under S. P. I. No. 22970. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

The Advocate of India has this to say of the White Alphonse mango: "We have at this moment on the office table a specimen of mango which has been sent us,—the like of which has never before been grown. It is a *White Alphonse*, perfect in shape, with a beautiful satin skin and a subtle aroma which faithfully indicates the delicate flavor of its golden pulp. It is a triumph in every respect, with the smallest stone for its size. Yet it is gigantic in weight and proportions. A good specimen of our Golden Alphonso, so far our best mango, does not weigh more than about four ounces. The *White Alphonse* just fails to tip the beam at the weight of two and one-half pounds." Michael.—Bureau of Plant Industry.

WOOTTEN CHUTNEY, Hawaii. See explanatory note under Lemon Chutney.

This name has been given to the variety because the only tree of the kind known is growing on the residence property of Mr. Harry Wootten in Honolulu. Size medium to large; color when ripe a shade between orange yellow and yellow orange, with tinges of pink and red at stem end; peeling qualities fair; texture very good; flavor excellent; seed rather small for the size of the fruit. An important characteristic of this variety is that while still solid it has a very beautiful color as if ripe, making it a desirable market form. It is one of the best of this class of mangos.—Higgins.

New and Little Known Trees Suitable for Southern California Avenues

DR. C. F. FRANCESCHI
SANTA BARBARA, CALIFORNIA

Southern California has started at last to build good roads, and there is no reason whatever why we should not have them as perfect as any in the world, because we are able to employ the best talent and the best materials, while our exceptionally equable climatic conditions are ideal for the maintenance of good roads.

If we need perfect roads we also need them to be beautiful, and it is obvious that more careful attention is going to be bestowed on the selection of trees which will prove best adapted either for ornament or for shade.

Everybody in Southern California is aware of the fact that we are able to draw upon almost any part of the world for ornamental trees, just as we do for all sorts of shrubs and other plants. Consequently, there will be much too many for this especial purpose. In this paper I am going to mention only such trees as have already proven themselves particularly desirable for planting along avenues or roadways of considerable length, and between sixty to one hundred feet wide.

The selection of trees best adapted for planting on streets in the residence sections of our towns is obviously subject to more special requirements and restrictions, and will not be treated in this paper. The question whether in Southern California deciduous trees must entirely be supplanted by evergreens I am not going to discuss, believing that either one class or the other might be preferable under different conditions.

As I understand it, the beauty of an avenue of trees resides principally in their uniform growth and in each individual tree being allowed to display its particular character and features, and not to become entangled with its neighbors.

Along such avenues, sixty to one hundred feet wide, and which, very likely, will not have cemented or asphalted sidewalks, trees which will eventually attain sixty to one hundred feet in height will not be objectionable, even if they grow a very big trunk.

Native Evergreen Trees

The following California native trees have already been planted on a more or less extensive scale and are sure to prove satisfactory:

Prunus integrifolia, "Island Cherry," "Islay," by some botanists considered to be only a form of the "mountain" or "wild cherry," but a native (exclusively) of Santa Cruz, Santa Rosa and Santa Catalina islands. Of rapid and pyramidal growth, the glossy foliage much varying in shape and size, but never holly-like. Will thrive in almost any kind of soil, and stand well heavy winds. May attain sixty to eighty feet; should be planted twenty-five to fifty feet apart.

Quercus agrifolia, the common "California Live Oak," will grow fast enough in tolerably good soil, and with plenty of moisture at the roots; in poor and dry soil will develop slower but will attain large size and a great age, as shown by the huge trees among the sandstone boulders on the ridge at Montarioso. May attain sixty feet, or over; being of spreading habit, should be planted not less than forty feet apart.

Quercus chrysolepis, "Golden-leaf Oak," "Canyon Live Oak," generally found higher up in the mountains than the preceding, and attaining about same size, but not such a fast grower.

Lyonothamnus floribundus var. *asplenifolius*, "Palo Fierro" or "Ironwood" of Santa Cruz and Santa Rosa islands; of regularly pyramidal shape, very conspicuous for its aromatic, fern-like foliage, and large umbels of white, strong scented flowers. May attain fifty feet and over, should be planted twenty or twenty-five feet apart.

Umbellularia californica, "Native Bay" or "Laurel," of dense, columnar growth, quite heavily foliaged, the strong scented, deep green leaves persisting for several years. Will not succeed far from water, may attain sixty to eighty feet, and occasionally much more, like the gigantic specimen at Cathedral Oaks, five miles north of Santa Barbara. Should be planted twenty-five or thirty feet apart.

Chamaecyparis lawsoniana, "Lawson Cypress." Surely one of the most desirable among conifers, on account of its feathery branches and pleasant green color. Will succeed even in poor soil and with little moisture, but much better under more favorable conditions. To retain its full beauty, not unlike most other conifers, its lower branches ought to be allowed to droop to the ground, and therefore it should not be planted at less than forty feet. There is no doubt that the most picturesque effect will be obtained if conifers are used only on sloping ground, in which position they will also thrive much better.

Libocedrus decurrens, "Incense Cedar," another very tall native conifer, more columnar in habit than the preceding, and not such a fast grower. Could be planted twenty-five to thirty feet apart. Not of feathery effect, but the emerald green of its foliage is very attractive.

Exotic Evergreen Trees

A certain number of conifers belong to this section, which have been planted more or less in our gardens and parks, but hardly at all for avenues.

Araucaria excelsa, the "Norfolk Island Pine" or "Star Pine," leads the list for its wonderful beauty and fast growth. I do not know of any other tree, no matter from whatever country, possessing such a distinctiveness of character, and such a solemnity of outline. But it could not be used for avenues under one hundred feet wide, and should be planted from sixty to eighty feet apart. It is not at all particular about soil, as shown in Santa Barbara where most numerous and most beautiful specimens are growing, both in the rich moist soil down town and on the dry hard-pan in the upper part of town.

Araucaria bidwillii, the "Bunya-bunya" of Queensland, will, at least in this country, grow not as tall and much slower than the preceding, and it appears to need also deeper soil and more moisture. But it is most impressive for its dense

pyramids of a dark green color. Should be planted not less than fifty feet apart.

Cunninghamia sinensis, from China, offers about the same outline as *A. bidwillii,* but with branches more drooping, the foliage of distinctly glaucous color. It will stand more cold and more heat, but needs deep soil and plenty of moisture at the roots, otherwise losing its lower branches and looking very unsightly. The finest specimens that I know of are at the Tevis place near Bakersfield, where the range of temperature is pretty wide, but soil is deep and moist. Plant fifty feet apart.

Cedrus deodara, or "Himalayan Cedar," is well known in gardens, but has never been much used as an avenue tree. I know only of the Santa Rosa avenue in Altadena, which is certainly very striking, but the effect is spoiled by the avenue not being wide enough and by the trees having been set much too close together. It should not be less than forty feet.

Cupressus sempervirens, the "Italian" or "Oriental Cypress," has been, of late much used (and abused) in California gardens. It is sure to make splendid avenues, like those of the most ancient and more beautiful villas in Italy, but one must not forget that in rich soil and with plenty of moisture, it is sure to lose its character and "to grow fat," its lateral branches spreading out under the overweight of foliage; also that the full effect of a cypress avenue cannot be obtained in only a few years. The spreading form of the Italian cypress, much despised in California, will make splendid trees, even in the poorest soil, having the same outline and offering the same scenic effect as firs and spruces, which are an impossibility here. If planted in rich and moist soil *Cupressus horizonthalis* will be at its best, displaying more fully its above mentioned character. The "columnar" form can be planted as close as sixteen or twenty feet, the "spreading" one will require at least twice as much.

Cupressus guadalupensis, "Blue Cypress" of Guadalupe island, not over seventy feet in height, and normally of a peculiar "ovoidal" outline, at least up to a certain age. Particularly recommendable for dry, rocky locations, growing naturally upon disintegrated lava currents. Quite "blue" in the young age, and its bark peeling off, just like cherry trees and *Araucaria cunninghamii.* With age it is much liable to vary, both in color and in outline, as I had the opportunity of remarking when in Guadalupe island many years ago. Plant from twenty-five to forty feet apart.

Cupressus arizonica, (Figure 80), from the mountains in northern Arizona, will retain its silvery color, better than the preceding. It will grow not quite as tall and will spread more at the base, while it will stand much more cold and any amount of drought. Plant from thirty to forty feet apart.

Australian Eucalyptus are recommendable for avenues, including the common *E. globulus,* "Blue Gum," which to this date has been used along roadways, probably more extensively than any other tree but rather as a most effective windbreak than for beautifying the same. The following kinds appear to be more particularly recommendable for avenues:

Eucalyptus citriodora, "Lemon-scented Gum," quite unique for its smooth, ivory white, tapering trunk, rising to one hundred and fifty feet, and for its

comparatively small but very regular crown, from which such delicious perfume exhales in foggy weather. Should be planted thirty to forty feet apart.

Eucalyptus rostrata, "Red Gum," almost as fast a grower as the "Blue Gum," and having the advantage of standing more cold in the young stage, and of being more graceful in shape and more uniform when full grown. Plant about forty feet apart.

Figure 80. Cupressus arizonica on its dry native heath.

Eucalyptus cornuta, "Yate," up to eighty feet high; highly recommendable not only for its standing saline and alkaline soil better than any other, but also for the very peculiar shining and plumy effect of its foliage. Should be planted at about forty feet apart.

Eucalyptus botryoides, "Bastard Mahogany," up to one hundred feet; a handsome, symmetrically shaped tree, standing drought well. Plant at forty feet.

Eucalyptus saligna, "Grey Gum," up to one hundred feet, of weeping effect like the "weeping willow," leaves also willow shaped. Plant at about forty feet.

There are also a number of species of *Ficus,* "rubber trees," from different countries which are particularly suitable for wide avenues.

Ficus macrophylla, "Moreton Bay Fig," is the most widely known, and it makes a magnificent tree, as one can judge from the few large specimens which escaped destruction during the wonderful extension of building in our Southern California cities. This should not be spaced under seventy-five to eighty feet, and it should be excluded from locations subject to heavy winds which may break too easily its heavily laden limbs.

Ficus rubiginosa or *australis,* also from Australia, will grow not as large. It has also smaller leaves, and it will stand more cold; will also stand the wind much better. Plant from forty to fifty feet apart.

Ficus bellingeri, from Queensland, appears to be a decided improvement on the preceding, but there are no large enough specimens as yet to form a positive judgment.

Ficus retusa, from India and Southern China (synonym *F. nitida),* is probably the species which has gained the widest reputation as an avenue tree. Much planted at Hongkong, in Algeria and in Sicily; there used to be some fine specimens in the center of Los Angeles, which had to give room to sky scrapers. It appears not to grow as fast as *F. macrophylla;* its foliage is thick and somewhat in the shape of the "strawberry guava." It will need good soil, plenty of moisture and plenty of heat to develop in the proper way. Plant at about forty feet apart.

Hymenosporum flavum, Queensland, up to one hundred feet; related to the *Pittosporums,* but finer than any of them. Fast and pyramidal growing, its branches slightly drooping and laden in spring with a profusion of jasmine shaped and jasmine scented, yellow flowers. Not at all particular about quality of soil, but not recommended for very dry places. Plant at thirty or forty feet apart.

Pittosporum rhombifolium, Queensland, up to eighty feet high; probably the tallest and the handsomest of all kinds introduced so far, not only for its very regular pyramidal shape, and peculiar foliage, but also for the great profusion of its yellowish white, fragrant flowers in summer, and of its shining bright yellow berries which persist almost all winter. Plant at thirty or forty feet apart.

Quercus suber, the "cork oak" of the Mediterranean basin. It has about the general outline of our native live oak, but will make faster growth, and is also interesting for its bark. Plant forty feet apart.

Sterculia gregori, (Figure 81), from Western Australia; the very best of all kinds of *Sterculia* or *Brachychiton,* "bottle trees," "flame trees," introduced so far, the finest specimen to be seen at Alhambra. Clothed down to the ground with glossy, coriaceous foliage which persists for many years, and sets out well the heavy bunches of salmon colored flowers which are produced for several months. May attain one hundred feet in height. Plant at forty or fifty feet.

Pircunia dioica, Argentina, the "Ombu" of the Pampas, "Bella Sombra" of the Spaniards who introduced it to Europe. In good soil will beat almost all other trees for quick growth and for beautiful shade, but will also stand drought won-

derfully well. It will in time build huge buttresses at the base, like those of many species of tropical *Ficus*. Should be planted about fifty feet apart.

Tipuana speciosa, Argentina, there called "Tipa," and considered one of the finest among native trees. May attain one hundred feet, and builds a straight

Figure 81. Sterculia gregori at Alhambra, California.

trunk, crowned by feathery foliage of light green color and drooping bunches of yellow flowers. Plant about forty feet apart.

Dendrocalamus latiflorus, from the island of Formosa, "upright giant bamboo." For low lands, and even where moisture might be excessive for other trees, clumps of this giant bamboo will make magnificent avenues, in the same way as they will make the most efficient wind breaks (if planted closer together). Does well also on drier ground, as can be seen in Montecito, etc. For avenues should be planted thirty to fifty feet apart.

Deciduous Trees

Acer macrophyllum, California. This has broader leaves than any other kind of maples that are found scattered on the northern hemisphere, and it is certainly one of the finest. In order to grow well and to retain its foliage until late it will need plenty of moisture at the roots, as otherwise the leaves will begin to drop in August or earlier. Same remark applies to other deciduous trees. This grows up

Figure 82. Cedrela fissilis planted in 1897.

to eighty feet, and should be planted thirty to forty feet apart.

Quercus lobata, California. "Valley Oak." "Roble" of the native Californians. In deep soil and with plenty of moisture this makes a truly magnificent, widely spreading tree, but could not be used under different conditions. May attain sixty or eighty feet; should be planted eighty to one hundred feet apart.

Platanus racemosa, native "Plane" or "Sycamore." While the oldest trees are often distorted in the most extraordinary ways, young trees can be easily trained to any desired shape, and this kind has a beauty of its own unrivalled by other deciduous trees. It may attain sixty feet or more, and should be set at least thirty feet apart.

Fraxinus velutina, "Arizona Ash." Grows fast and very symmetrical in shape, with branches gracefully drooping, and it has the great merit of growing well in alkaline soil where hardly any other tree will do. Grows up to sixty feet or more. Should be planted thirty to forty feet apart.

Cedrela fissilis, (Figure 82), Paraguay and Brazil, "Brazilian cedar wood." For avenues where not much shade is required this is sure to be a first class deciduous tree, its trunk rising up straight to a considerable height without branching, the branches never very heavy and forming a symmetrical head. Finest specimen to be seen in my old garden on State street in Santa Barbara which I planted in 1897, and must be now about sixty feet high. Timber is also very valuable, much like "Cuban" or "Spanish Cedar," *Cedrela odorata*. Should be planted thirty to forty feet apart.

Plants and Plans for Small Places, II

R. D. CORNELL
LONG BEACH, CALIFORNIA

"True art is the art of concealing art." This is especially true in landscape work. The most beautiful landscape effect, produced by man, is that which most closely resembles nature's own creations, and which reveals no trace of man's invasion. Such an effect can, however, be produced only on a large scale.

The grounds of the city home afford too confined an area to make possible such an attempt. But the smallest plot will respond to proper treatment in a way at once surprising and delightful. We must take conditions as they are, weigh them, and make the best of them. In our selection of plantings, interest is greatly increased by choosing those plants that are unusual and seldom seen. Among the rarer trees proven hardy in Southern California are: The silver tree or *Leucadendron argenteum,* a tree of pyramidal growth and silvery foliage; *Lyonothamnus floribundus,* native to our Channel islands and worthy of more attention; *Maytenus boaria,* which is a low growing tree of delicate foliage and graceful habit; *Salisburia adiantifolia,* or the maiden hair tree; *Parkinsonia aculeata,* and *Lagunaria patersonii.* These, with a possible list of many others, are both obtainable and desirable.

Among the shrubs are numbers of the *Bauhinias* and *Hibiscus; Choisya ternata* which is a frequent and abundant bloomer; *Gardenia florida,* or the fragrant cape jasmine; and *Coprosma baueriana,* whose glossy foliage is remarkably dust proof.

Among the vines are the passion vines, *Bignonias, Jasminums, Solanums* and *Bougainvilleas. Bougainvillea laterita* is especially beautiful with its abundance of brick-red bracts.

Landscaping is considered by many to be a luxury. It is economy; economy of the most practical sort. A home site with a few thrifty trees and shrubs growing upon it will bring a price far greater than the same plot before it was planted, and will pay a good big interest on the added expense of improvement.

Where the limited space of restricted quarters must necessarily be considered, it is well, both from the standpoint of economics and of personal satisfaction, to combine the useful with the decorative. This can very readily be done. There are now many subtropical and tropical fruits of unusual flavor and food value, as well as beauty, which have become acclimatized to our Southern California conditions, and which are fast becoming popular with the people. Among the most important of these may be classed the avocado (*Persea gratissima*), which seems destined to become an important factor in the horticultural sphere of Southern California. The *Feijoa sellowiana* is an exceptionally showy shrub with beautiful flowers, silvery foliage and fruit of rare quality. This shrub will stand a wide range of temperature and is a great drought resistant. The mango bids fair to

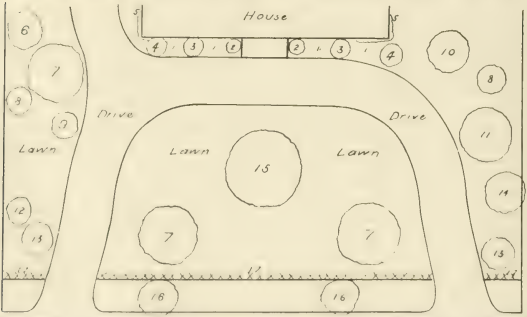


Figure 83*. 1, annuals; 2, Hydrangea hortensis; 3, Alsophila australis; 4, Grevillea thelmanniana; 5, climbing rose; 6, Streptosolen jamesoni; 7, Washingtonia robusta; 8, Plumbago capensis; 9, Pittosporum tobira; 10, Pittosporum undulatum; 11, Cedrus deodora; 12, Genista canariensis; 13, Yucca gloriosa; 14, Acacia floribunda; 15, Phoenix canariensis; 16, Schinus molle; 17, hedge of Ligustrum.

* The home shown in Figure 83 would make a beautiful picture if the three palms were taken from the center of the front yard and if the hedge were grubbed out. As it is, the place is almost entirely hidden from the street. The plantings close to the house are in harmony and the groupings at the sides are good with one exception—the cedar should have been placed behind the smaller shrubs. Here we find the possibilities of beauty but cannot enjoy it because of the barrier of foliage in front.

The tendency, generally, seems to be to overplant and to place things but or miss. This can be avoided by giving the matter a little attention at the time of planting and construction. One should have in mind, or on paper, a clear idea of the home-to-be, before any planting should be done. Decide upon the impression you would have your home make, determine the motif of the picture, and subordinate the details to the main theme.

become a permanent resident of this locality, and the Queensland nut (*Macadamia ternifolia*) has already proven to be a successful fruiter here. In addition to these, are the *Anona cherimolia*, Sapote blanco, numerous of the guavas (gen. *Psidium*), the loquat, citrus fruits and several of the *Eugenias*, all of which are useful and desirable as ornamentals aside from their fruiting value and interest.

From what I have just said, do not infer that, in landscape art, stress should be placed upon the individual or specimen tree. This would be contrary to all

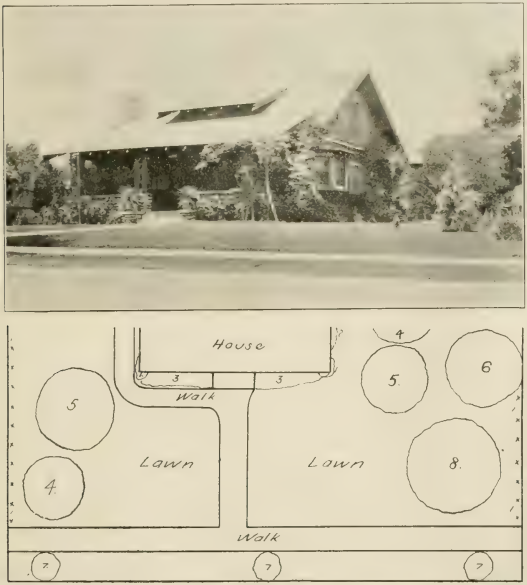


Figure 84*. 1, roses; 2, Bougainvillea spectabilis; 3, geraniums; 4, oranges; 5, Phoenix canariensis; 6, Cocos plumosa; 7, Washingtonia robusta; 8, Cedrus deodora.

* The accompanying half tone and diagram, Figure 84, shows more than ordinary taste in the arrangement of plants on a small scale. The vines on the porch, the hanging baskets and the herbaceous plantings along the foundation all tend to soften the outline and give a pleasing, comfortable appearance. The trees are assembled at the sides, leaving an open front and giving the impression of spaciousness and ease. The cedar should, by all manner of means, have been placed at the extreme rear of the group, as it will in time attain to such a size as to conceal everything now planted behind it; while if properly placed it would lend strength and majesty to the group, instead of completely hiding it.

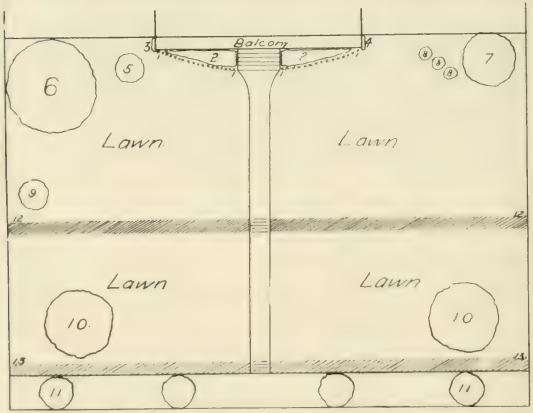


Figure 85*. 1, Centaurea gymnocarpa; 2, Scarlet geranium; 3, Bougainvillea spectabilis; 4, climbing rose; 5, Fatsia papyrifera; 6, Cedrus deodora; 7, Dendrocalamus strictus; 8, Fourcroya; 9, Grevillea thelmanniana; 10, Phoenix canariensis; 11, Cinnamomum camphora; 12, terrace in lawn; 13, terrace in Mesembryanthemum.

* Figure 85 is representative of a neat but rather stiff treatment of a yard in which a medium grade is encountered. The planting along the foundation is good and the open front is commendable, but the terracing is poor.

The grading should have been done by making one long, easy slope, convex at the upper part and concave at the lower; gradually approaching a level, though always falling away from the level of the house. Or the grade might be carried down by a double curve, of like character, and two terraces. See Figure 86 for cross section diagram of the grade as it now is and as it might be.

The planting would be improved by the massing of shrubs along the sides and rear of the yard

ideals of landscaping. As the name implies, we are striving for a picture in color, in outline, in effect. Anything which attracts attention because of its individual appearance, detracts from the motif of the picture, and one soon finds himself studying the details, with no impression of the place as a whole. "Landscape pictures are not collections of interesting objects" says a prominent landscapist. Their impression should be as that of a picture on canvas, with one predominating idea, to which everything else is subordinate. In the city home the house should be the main theme, with the yard and plantings as the setting and background.

Everything should be planted in groups or masses. Do not stick trees and shrubs into miserable little holes in the lawn. Do not mar the beauty of your home by inserting flower beds in the centers of open spaces. Always keep the front open, as well as the views from the windows, unless it should be desirable to conceal some unsightly object. Trees and shrubs should be massed along the sides

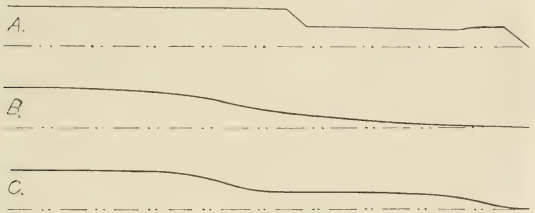


Figure 86. Showing grading of yard in Figure 85 as it is and as it might have been.

of the lot with the taller ones in the rear, thus forming a bank of foliage. An excellent place for your flower bed will be in irregular form along the edge of your shrubs. The angles and the masonry of the foundation can be softened by judicious planting of low growing things, arranged in natural and easy positions.

Sidewalks, drives and masonry should never be used unless absolutely necessary, as they detract from the desired effect and should come under the head of formal gardening. The fearful and wonderful creations made by the pruning shears and seen in the carpet beds belong to ornamental and formal gardening. Formal and ornamental gardening are widely separated from landscape gardening. The former two require skill in architecture, in stone work, in plant butchery. The latter requires love and appreciation of nature, a true ingenuity and a sense of beauty, harmony and fitness.

And thus, while it is interesting and often desirable to plant specimens for their individual value, if you wish a pleasing picture, do not allow the individual to attract undue attention, but place it with its comrades. Plant in groups. Strive for harmony in flower and foliage, ease in outline and natural effect. Have in mind the picture and work to that end. At the same time, every detail of the picture should possess interest as well as beauty.

Southern California and Java

A STUDY IN HORTICULTURAL ENTERPRISE

C. F. BAKER

POMONA COLLEGE, CLAREMONT, CALIFORNIA

Java is not a large country—only a little larger than Southern California. It is a country rich in soil and vegetation, yet only about forty per cent. of its territory is said to be under cultivation. It supports a very large population for the size of the country. Its government is administered by the Dutch in a very paternal fashion, but by far-sighted and most intelligent methods. The natives are not highly intellectual nor energetic, so that the present prosperous state of the Island of Java with its now above $150,000,000 of agricultural products per year, must be attributed to those who administer its internal affairs. Other countries and colonies the world over have studied the Javan results with deepest interest. Especially interesting to Southern California, with what is said to be the most highly educated farming community in the whole world, and which aspires to great success in agriculture and horticulture, will it be to examine into the causes of the Javan results with a community largely illiterate.

In the recently published English translation of that wonderful study by Cabaton, "Java and the Dutch East Indies," we do not find it hard to read the cause of the magnificent success of the Dutch in Java, in their painstaking and unremitting efforts to investigate scientifically and thoroughly all of their conditions, and their agricultural problems, and to apply the results. For instance, in connection with the culture of coffee, Cabaton says: "In view of the important part which the cultivation of coffee plays in the colony, the laboratories of Buitenzorg and the experimental gardens are busily increasing their research work with a view to attacking the parasites of the precious shrub, and to introducing the more productive and resistant varieties. The planters themselves have even founded a station at Buitenzorg which deals with coffee, and they do not, as a rule, undertake the planting of coffee until they have undergone a serious course of study at the Agricultural College of Wageningen in Holland, where the department of tropical agriculture and arboriculture, together with the courses in Malay and the ethnology of the Archipelago, afford them a very excellent training for the purpose."

Has Southern California any similar activities to show in connection with orange culture, or any other of our great horticultural interests? We are willing to pay thousands to develop and protect the sale of our products but nothing to bring about more efficient and more effective and more economical production, while as a matter of fact our margin of profit is as likely to be built up by the latter method as by the former. Our growers pay shocking prices for experience laboriously gained without previous preparation or technical knowledge to back it up. Thousands upon thousands of dollars are annually lost in the citrus business in our present lack of system in fumigation work, and in the widespread unwisdom with

which commercial fertilizers are used. For the more exact knowledge that we must have, we sit back and await the tardy, long distance action of the Federal Government, or the action of state institutions that cannot adequately serve the other agricultural interests of the state, to say nothing of our own peculiar subtropical interests. Young men come to us in numbers, inquiring where they shall go for technical preparation for citrus culture, exactly such as is described above as splendidly in operation in the interests of Javan coffee culture. What can we tell them? Simply this—that there is *no place of the sort to go to in the State of California—not even in Southern California, where citrus culture is supposed to be the greatest industry!*

We have county organizations to serve our horticultural interests, that might be built up into towers of strength to us, that might attract to our service the best specialists in the country, that might yield to us much of the many urgent expert services that we so much require, while almost without exception we have relinquished these whole possibilities to become the spoils of politicians, and to men of no technical training whatever. While all intelligent growers groan under this abuse, they have not acquired the courage to take advantage of the recall which the law provides as a ready means of relief from this irksome and clogging parasitism.

It almost makes the horticulturist wish he was a Javanese to read further from Cabaton, as follows: "The State has demonstrated its ardent desire to assist both colonists and natives in the intensive agricultural development which is making the fortune of Java. The Botanical Institute of Buitenzorg is not the least happy of its efforts. This establishment, which has no rival in the world, is not merely a marvellous assemblage of all the products of the Archipelago: its object is practical as well as scientific. Beauty is only its outward form; truth and utility are its inner purpose. It comprises the Botanical Garden proper of 145 acres at Buitenzorg itself, and as annexes the experimental gardens at Tjikeumeu, of 180 acres; the mountain gardens of Tjibodas, which have a much larger area; and finally the virgin forest of Tjibodas, of 700 acres. At each of these establishments are laboratories, museums, libraries, herbaria, and collections, directed by scientists of the highest rank, from the founder of the Institute, Professor Reinwardt of Amsterdam, to the last Director, the eminent Dr. Treub. In the experimental gardens attempts at the acclimatization of foreign plants and trees of agricultural value are carried on uninterruptedly; the degree of resistance which they offer under determined conditions is studied; experiments are made in the crossing and improvement of the flora of the country; in short, the practical value and uses of the whole flora are investigated. In the laboratories, on the other hand, are studied vegetable parasites, noxious insects, chemical manures, etc.—all that is capable of destroying or enriching that flora. The service which these laboratories have rendered in investigating the maladies peculiar to sugar cane, tobacco, and coffee, has been so great *that private individuals have built such laboratories at their own expense in many parts of Java, for the better guidance of their own plantations!* This Botanical Institute, so noted for its purely scientific labors, as well as for its practical advice, costs the East Indies 342,400 florins

a year, or £29,360, while the budget of agriculture alone amounts to 7,200,000 florins (£600,000) which sum is employed in the introduction of new crops or the improvement of those already existing in Java."

And little Jamaica, almost exactly the size of San Diego county, has two great botanical gardens which have been of equally great utility, manned by equally well trained scientific men, and which have played equally as important a part in the development of the country they serve.

Coming directly from her own resources and support, Southern California with all her great possibilities and her great riches, *has absolutely nothing of this sort*,* and what little comes from outside support *is utterly inadequate and ineffectual* in the face of the great work to be done! Southern California could have as splendid a service along all these lines as any other part of the world, by any one of five different means:

1. Our county service, now installed, but utterly ineffectual, could be reorganized and placed on an efficient basis, manned by trained men, and amplified to fully meet the requirements. Great results would be possible with what we are already squandering in it. If the larger part of our growers *stood* for this thing it could be done immediately under existing laws.

2. By the employment of scientific men, and somewhat of addition to equipment and working force by assistance from the county or from growers' associations, our public parks could easily give up ground to experimental work and laboratories that would be among their greatest attractions, and yield to the whole commonwealth some of the great benefits that can come from such work.

3. The Federal Government or the State could establish here a garden similar to the one already established at Chico, and by properly manning it, amplify it into the needed institution. This would, however, involve an act of Congress or of the State Legislature.

4. A levy of a few cents per box on the citrus fruits sent out of Southern California *would build and support a magnificent institution* which should be the property of and controlled by the citrus growers and which should serve their interests in the most direct and effective way. It would be a paying investment and in the end a great practical economy.

5. There are single men of wealth, and many groups of such men now in Southern California, who could amply afford to found and endow a great institution of this sort which should be built upon a broader and better plan—*to serve all the agricultural and horticultural interests of the whole community*, and which should be a blessing and a source of strength to the whole region through all the coming years of great development!

Surely out of all these possibilities something must soon come!

*Exception must be taken to this generality in the case of the valuable bulletins published by the Claremont Pomological Club, and also the Pomona Journal of Entomology and the Journal, the two latter supported by certain ambitious groups and individuals among the citrus growers. None of these projects, unfortunately, although of the greatest possibilities in public service, are yet permanent projects with assured support. In so far as they have been carried they represent a highly progressive and laudable movement which should certainly not be allowed to languish.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II FEBRUARY 1912 Number 1

Feijoa Sellowiana; Its History, Culture and Varieties

BY F. W. POPENOE
WEST INDIA GARDENS, ALTADENA, CALIFORNIA

Among the fruits which have been offered as commercial possibilities in California there are few which possess such intrinsic merit as the one here considered.

The Feijoa is comparatively new to horticulture. It has been in cultivation but twenty years, and in this country scarcely ten. Therefore our knowledge of the plant and its requirements is as yet elementary, and the important subject of varieties, in particular, is in a chaotic state.

But here is a shrub, unusually valuable as an ornamental—so much so that it is grown as a pot plant for the beauty of its foliage and flowers in European conservatories. To this attractiveness, and greatly overshadowing it, is added the value of the fruit—of oval shape, greenish in color, highly perfumed, and with a flavor indescribably delicate and delicious. Supplementing these qualities, and augmenting them, is its hardiness. The Feijoa will grow and thrive not only in California, but throughout the entire coast region, and across the continent from the Pacific to the Atlantic, in the southern belt embraced within the Gulf States. Certainly few plants can offer such an appeal to public favor. Everyone who is familiar with the Feijoa to a sufficient degree, has the greatest confidence in its future. It is a fruiting shrub of sterling excellence. As a commercial fruit it offers great promise. Its admirable shipping and keeping qualities justify for it an expectation that it will become a market fruit of the first class.

History of the Feijoa in Europe and North America

Upon returning from South America in 1890, the late Dr. Edouard Andre, one of the most noted French botanists and horticulturists of his day, brought with him from La Plata, Brazil, a layered plant of Feijoa Sellowiana. This specimen was set out in his garden, Villa Colombia, on the Riviera, and bore fruit in 1897. In the following year Dr. Andre published in the Revue Horticole, of which he was editor, a description of this plant, together with a colored plate showing the foliage, flowers, and fruit. From the behavior of his plant at Villa Colombia, he felt justified in strongly recommending the Feijoa for southern France and the entire Mediterranean basin, and described the merits of the fruit

in the most favorable terms. He announced that layered plants, propagated from his bearing specimen, would be obtainable the following year from a nurseryman at Lyons.

Coming from such an authority as Dr. Andre, this article created a considerable demand for plants, and a number of them were disseminated during the following year, the majority being planted on the Riviera, but not a few going to Italy and Spain, and some to conservatories in more northern countries, where it was thought the climate was too severe to permit of their being grown in the open. The next three or four years saw a considerable number of Feijoas planted along the Mediterranean, and the cultivation of the plant fairly established.

As far as is definitely known, Dr. Andre was the first to introduce the Feijoa into Europe; certain it is that he was the first to realize its horticultural possibilities and to give attention to it from this standpoint. It is possible, however, that an introduction antedating that of Andre by several years may have been made in Switzerland. A plant is growing in the Botanic Garden at Basle which is believed to be twenty-five years old. Definite date in regard to the introduction of this plant is lacking, but previous to its cultivation in the Botanic Garden it was cultivated by M. de Wette, and there seems no reason to doubt that it is as old as it is claimed to be. Andre introduced the plant twenty-two years ago. As far as is known, he did not bring from South America any other specimen or specimens than the one planted in his own garden, and there is no record of any plants having been propagated from this until 1898—fourteen years ago. This makes it almost certain that the plant at Basle was a separate introduction, and while there is no actual proof that it was introduced previous to Andre's plant, there is a considerable possibility that it was.

In 1899 Besson freres, well known nurserymen at Nice, decided to propagate the Feijoa extensively and made an importation of seed direct from Montevideo, Uruguay, from which several thousand plants were raised. These were disseminated almost as widely as those from Andre's plant. The particular interest of this importation lies in the fact that the plants turned out to be of an entirely distinct type from the Andre bush.

One or two other small importations of seed from South America were made by French nurserymen, but no large number of plants were raised, and they were not widely disseminated, so that practically all of the Feijoas in both Europe and North America can be said to have originated from either Andre's introduction or the importation of seed by Besson freres.

In 1901 Dr. F. Franceschi of Santa Barbara, California, obtained a number of seedlings from Andre's original plant through M. Naudin of Antibes, France. These plants were disseminated at once, and were set out in several different locations in Southern California, notably Orange, Redlands, and Altadena, as well as those planted at Santa Barbara by Dr. Franceschi himself. Two years later, in 1903, Dr. Franceschi obtained from F. Morel of Lyons, who was authorized by Andre to sell layered plants from the parent bush, a number of these layered plants, of which the majority were sent to Florida, although one or two were planted in Santa Barbara.

Figure 87. The first Feijoa planted in Europe. This plant was brought from Uruguay in 1890 by the late Dr. Edouard Andre and planted at the Villa Colombia, Golfe-Juan. It is the parent of the majority of Feijoas in both Europe and North America. Mr. Paul B. Popenoe in foreground.

These plants introduced by Dr. Franceschi, which it is seen were all seedlings or layers from Andre's original plant, are the parents of nearly all the Feijoas which have been propagated in California up to the present time. An importation of seeds from Argentina was made by H. Hehre of Los Angeles, at an uncertain date, and while the plants which were the result of this importation have not been widely disseminated, one of them has proved to be of an entirely distinct form from any of the Andre seedlings, and has resulted in the Hehre variety.

Botanical Description and Affinities

Feijoa Sellowiana was named by Berg after material collected by Friedrich Sellow in the province of Rio Grande do Sul, Brazil, not far from the frontier of Uruguay. Berg's description was published (in Martius, Flora Brasiliensis, XIV, 1, p. 616) in the year 1858, under the name of *Orthostemon Sellowianus*. The generic name *Orthostemon* had already been preempted by Robert Brown for a genus of Gentianas founded by him, and it is evident Berg soon discovered his mistake, for in the same volume of the Flora Brasiliensis (the work was originally issued in small parts) he records the change and dedicates the genus to Joam de Silva Feijo, Director of the Museum of Natural History at San Sebastian, Brazil.

While Berg's description was the first one published, it is somewhat inadequate for the reason that it had to be made from the meagre herbarium material collected by Sellow, in possession of the herbarium of Berlin; and particularly, as pointed out by Andre, that no mention was made of the form of the petals, nor of the color of the corolla. Dr. Andre, having the living material at hand in the form of the adult plant growing in his garden, undertook to draw up a complete and accurate description of the species. This was published in the Revue Horticole (Vol. 70, p. 265) and a translation of it is as follows:

A bushy shrub, 3 to 4 metres in height, with rounded branches swollen at the nodes, covered with light gray bark, the young branches tomentose, as is the whole plant except the upper surface of the leaves, and the corollas.

Leaves opposite, obtusely elliptical, shortly petiolated, thick and coriaceous, the upper surface glossy and of a fine green lustre, the margins slightly recurved, veins scarcely noticeable above, but fine, prominent, and in arcuate reticulations below, re-uniting before reaching the margin of the leaf; the lower surface canescent and finely puberulent. Buds globular, puberulent, constricted above the ovary. Flowers solitary or in clusters, in the axils of the leaves; peduncle straight, then recurved, 20 to 25 millimetres long, whitish and velvety. Calyx tube turbinate, sepals four, unequal, obtusely elliptical, recurved, pubescent, ciliated. Corolla outspread, petals four, cupped, oval or obovate, entire or marginate, obtuse, fleshy, glabrous, ciliated, white outside, violet red inside, 15 to 18 millimetres long and 8 millimetres wide, recurved after anthesis. Stamens numerous, perigynous, erect in a large cluster, 20 millimetres long, filaments filiform, deep purple, anthers globular, yellow. Style longer than the stamens, filiform, slender, stigma capitate; ovary quadri-locular, oblong, turbinated. Fruit a berry, oblong or ovoid, with 4 polyspermous loculaments, 4 to 6 centimetres long and 3 to 5 centimetres wide, green even when ripe, surface first tomentose, later smooth, slightly furrowed, rough, crowned by the thick disk and cupped sepals of the persistent calyx. Seeds small, oblong.

Flesh thick, white, pulpy and watery, of a sweet and highly perfumed taste, suggesting pineapples and guavas and exhaling an extremely bland and penetrating odor, even before the maturity of the fruits.

The genus *Feijoa* is a member of the Natural Order *Myrtaceae*. Among the well known economic members of the order are the Guavas (*Psidium*), numerous

species of *Eucalyptus*, the Brazil Nut (*Bertholletia excelsa*), Allspice (*Pimenta officinalis*), Nutmeg (*Myristica fragrans*), and several species of *Eugenia*, notably the Rose Apple (*E. jambos*), and Clove (*E. caryophyllata*). All are natives of tropical or subtropical regions.

Feijoa is quite closely allied to *Psidium*, from which it differs only, according to Nicholson (Dictionary of Gardening) in the elongated ovary, in the filaments being erect in bud (in which respect it differs from all other members of the order), and in its hairy anthers. The foliage of *F. Sellowiana* gives it a false

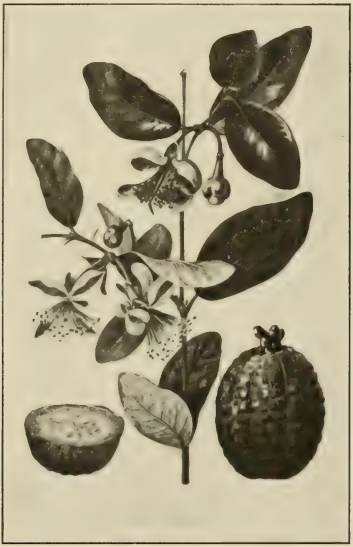


Figure 88. Foliage, flowers, and fruit from the original Andre tree (after Revue Horticole, 1898).

appearance of *Eleagnus*, and it is also somewhat similar in appearance to the Olive (*Olea europaea*), except for the larger size of its leaves.

While *F. Sellowiana* is the only species that has been given any horticultural attention, two others have been described. These are:

F. obovata Berg (Martius, Fl. Bras. XIV, 1, p. 616), which was named after specimens collected by Sellow in the same province of Brazil as *F. Sellow-*

iana (Rio Grande do Sul), and presumably collected at the same time. According to Andre, *F. obovata* differs from *F. Sellowiana* in its lesser height, its compressed branches, and its pointed and pellucid leaves. It has probably never been introduced to horticulture, and its fruit is unknown.

F. Schenckiana (Kiaersk, Enum. Myrt. Bras., p. 186, t. 26, fig. A) is a species much more recently described (1891). From a copy of the original description kindly furnished by the Director of Kew Gardens, it appears that the species differs from *F. Sellowiana* in having oval leaves, and white petals, with other minor differences. It occurs in the highlands of the province of Santa Catharina, Brazil. Its fruit is unknown.

F. Sellowiana appears to be of common occurrence in the wild state in certain parts of Brazil, Uruguay, Paraguay and Argentina. See under "The Feijoa in South America" for more definite data in this connection.

Common Names

During the few years in which it has been cultivated in California the Feijoa has had at least three names applied to it by nurserymen and horticulturists. These are "Pineapple Guava," "Brazilian Guava" and "Fig Guava." The first can not be said to be objectionable, but the other two are somewhat inappropriate. The fact that the Feijoa is called "guayabo" and "guayabo del pais" by the natives of Brazil and Uruguay denotes that it is considered as a guava by them, and its close relationship to the guavas makes the use of this name allowable. But if the Feijoa is to be considered as a guava, and called by this name, some additional term should be used which will distinguish the Feijoa from the more or less inferior guavas. The distinct pineapple flavor of the Feijoa has suggested the appellation "Pineapple Guava" and as this name is fairly attractive, and conveys a correct idea of the nature of the fruit, no objection can be raised to its use. "Brazilian Guava" implies but little, and is not sufficiently distinctive, since there are many species of guava which are natives of Brazil. "Fig Guava" is probably founded on some slight similarity, real or otherwise, between the Feijoa and the fig, but as this similarity is extremely slight this name can hardly be accepted as the best.

In Europe no common name appears to have been given the Feijoa, and as a matter of fact, the use of the generic name is much more general in California than any other. While this name is somewhat difficult for those not familiar with it, to pronounce, there can certainly be no objection to its use. And as it is under this name that the plant has become established in California, it is probable that it will continue to be known under the same name.

There has been considerable difference of opinion in regard to the pronunciation of "Feijoa" in California. These differences seem to have been the result of a misunderstanding of the derivation of the word. Many have been misled by the belief that the name "Feijo" from which the generic name is derived is Spanish, and consequently have given j the sound of h. But the name is Portuguese, and according to the very best authorities is pronounced Fay-zho-a, accenting the middle syllable. This is the pronunciation that is used in France and in the Botanic Gardens in other parts of Europe.

The Feijoa in California

The seedlings which formed Dr. Franceschi's introduction in 1901, and which are scattered over the southern end of the state, have been notably successful. They have been grown under widely different climatic conditions, from Santa Barbara to Redlands. Being seedlings, some of them have produced fruit of indifferent quality, and while only a few have proved to be really superior, they

Figure 89. A seedling of the Andre Feijoa at Villa Valmer, Marseilles, France. Note size of fruit in basket in foreground. Back of basket stands Alfred Rivier, head gardener at this place.

have demonstrated that California is admirably adapted to the Feijoa—doubtless much better adapted to it than southern France, where it has been grown so successfully.

Outside of its trial in the southern part of the state, it has been tested at Santa Rosa, and even as far north as Eugene, Oregon, at both of which places it

has proved perfectly hardy. And from our knowledge of the hardiness of the plant, gained from the experience of the European growers, it is safe to say that it will be hardy in practically all parts of California, except at very high altitudes where low temperatures are experienced.

Since the first importation of plants has come into bearing, many seedlings have been raised, some of which are now in bearing. While the variation which is natural to all seedling fruits has been exhibited by the Feijoa, and many of the seedlings have been disappointing, where good care has been bestowed upon the plants the results have, in the great majority of cases, been highly gratifying.

During the last few years several thousand seedlings have been raised and disseminated by the nurserymen. Most of these have gone into private gardens, although several small plantations have been made, the largest of which is that on the Henry E. Huntington estate near Pasadena, and consists of about four acres. The plant has been used in a few instances as an ornamental hedge, for which purpose it has proved to be admirable.

During the past season a small quantity of the fruit was placed on the Los Angeles market and retailed at fifty cents per pound.

California soils, if properly handled, seem to be particularly adapted to the Feijoa, and the climatic conditions of most parts of the state have proved to be most favorable to the development of the plant and the perfection of the fruit. It has not been tried as yet in strictly desert regions, but it has been grown as far into the interior as Redlands. There is no doubt but that when the requirements of the plant are thoroughly understood and supplied it will reach a high degree of perfection in this state.

The Feijoa in France

In southern France the Feijoa has been given more attention from a horticultural standpoint than in any other country. Yet almost nothing is known of its requirements or varieties, except by a few horticulturists, and there are but a few dozen good bearing plants in the entire country. Dr. Andre considered it "one of the most important and most useful to horticulture of the hard-wooded plants which he introduced into Europe on his return from La Plata in 1890." Why this valuable fruit, in the fourteen years that have elapsed since it first came into bearing, and in which it has been offered by the trade, has not assumed a greater importance and become more widely planted, may perhaps be explained by the statement of Viviand-Morel (Lyon-Horticole, XXXII, 1, p. 16): "Exotic fruits do not please everybody—we have so many in our own country that are worth more than the mango, banana, pineapple and avocado of the tropics." The French attitude toward horticultural novelties of this character is certainly not like the American. Not knowing the value of the Feijoa from their own personal observation, and being satisfied with the fruits they already have, the French gardeners are content to leave the culture of this fruit to someone else. It is only through the persistent efforts of those broad minded horticulturists who have the perception to realize the value of such a fruit as the Feijoa, of which may be mentioned such men as Dr. Robertson Prochowsky of Nice, M. Clement Nabon-

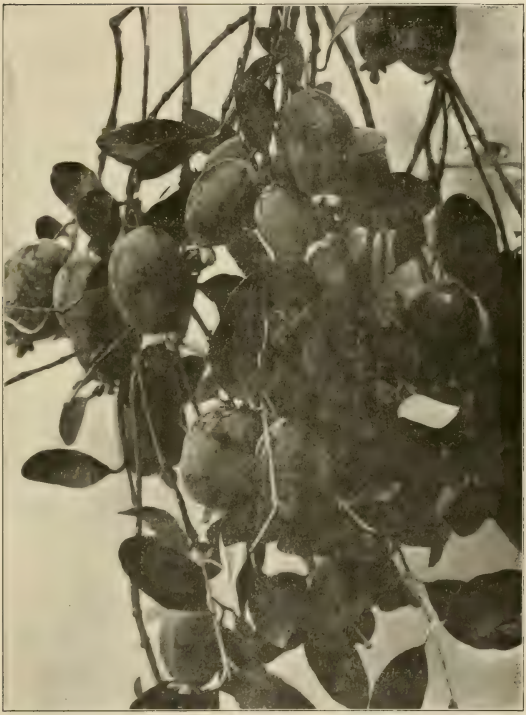


Figure 90. Fruiting branch of a seedling Andre Feijoa at Marseilles, France, showing an average productiveness. These from trees shown in Figure 89.

nand of Cannes, and M. Viviand-Morel, editor of the Lyon-Horticole, that this fruit can ever be established on a commercial basis in France.

My data in regard to the Feijoa in France and other European countries, and some of the illustrations presented herewith, are the result of the investigations of my brother, Paul B. Popenoe, who devoted a month to the study of the subject, in the interests of the West India Gardens.

The Riviera has proved to be well adapted to the culture of the Feijoa. Although the winters are cold, the temperature sometimes getting as low as ten degrees (Fahr.) above zero, unprotected plants are not injured, and produce abundantly. The twenty-year-old plant at Villa Colombia, Golfe-Juan, brought by Dr. Andre from South America, is now an immense bush, fifteen feet in height, covering a space of ground eighteen feet in diameter, and with a trunk eight inches thick at the base. The crop is estimated by M. Clement Nabonnand at two thousand fruits. The winds coming from the Mediterranean frequently blow off part of the fruit before it is mature, and although it can be ripened in the house, it is not as good as though allowed to reach full maturity on the tree.

One of the most successful cultivators of the Feijoa is Alfred Rivier, *chef du culture* at Villa Valmer, near Marseilles. The plants grown by M. Rivier are seedlings from Andre's bush, and are even better than the parent. Among other successful growers may be mentioned Abel Gorre at Menton, who grows both the Andre and Besson types; Francois Mangan, also at Menton, and Dr. Robertson-Prochowsky, the well known systematic botanist at Nice. Occasional bearing plants are found in the gardens along the Riviera in Italy as well as in France. There are also a few in Spain.

M. Viviand-Morel believes that the Feijoa will in time take an important place among the commercial fruits, not only on the Mediterranean coast, but also in Provence, and the South and West of France. Certainly there is no reason why it should not do so, other than the difficulty in establishing any new fruit upon a commercial basis, and although progress toward such a state has been anything but rapid, it is to be hoped that the horticulturists of southern France will devote more attention to the Feijoa in the future than they have in the past.

The Feijoa in England

As a fruiting shrub, the Feijoa does not seem to be a success in England, but its cultivation in a limited way as an ornamental is possible, and this alone speaks volumes for the hardiness of the plant. The following extract is taken from an article on the subject by A. C. Bartlett, published in the Gardeners' Chronicle (Ser. 3, XLVIII, p. 242): "The best plants I have seen were grown in yellow loam, and were trained against a southern wall. Under these conditions the species made fine, healthy branches. They require liberal waterings during hot, dry weather, until the beginning of August, from which time attention should be paid toward ripening the growth already made; otherwise the plant is almost certain to be injured by the first heavy frosts. Although the natural habit of the Feijoa is that of a shrub or small tree, there are few places in these islands where it could be grown in this way with any likelihood of success, therefore the protection of a

Figure 91. Fruits of an Andre seedling grown at Marseilles, France, natural size. These from trees shown in Figure 89.

wall is essential." Mr. Bartlett goes on to state that the fruit does not seem to ripen under cultivation in that country. He recommends it strongly as a wall shrub, however, and considers it well worth growing for its handsome foliage alone.

The Feijoa in Florida

Reports on the behavior of the Feijoa in Florida are not encouraging. While as yet it has been tested at very few points, and some parts of the state may prove to be adapted to it, past experiments do not promise extensive future development.

At Gotha, the Feijoa has been grown for several years by Dr. H. Nehrling. Regarding the behavior of his plants he writes under date of October 16, 1911: "The Feijoa has fruited with me this year as well as last season. It grows beautifully, has fine flowers, and would be a great ornament to any collection of exotic plants. I have two specimens, both coming from the Department of Agriculture. The fruit is about the size of a *small* walnut, entirely glossy green and only slightly fragrant when ripe. Both of my plants grow in half shade in my Caladium shed, and perhaps for this reason the fruits drop when still unripe. The flavor is not very good, and after having dropped the fruit immediately begins to rot, assuming a dark brown or blackish color and becoming soft and tasteless. The plant thrives splendidly, though we have had no great cold since I began to grow these plants, the thermometer never going below about 28 degrees Fahrenheit."

The Feijoa has also been grown at the Subtropical Garden of the U. S. Department of Agriculture at Miami, but so far has not done as well as at Gotha. The plants bloomed last season but did not set any fruits, according to the statement of Edward Simmonds, gardener.

It will require a more thorough test to definitely decide the matter for any part of the state, but it seems quite probable that the Feijoa has greater chances of being a success in the more northern sections than under the almost tropical conditions of the east and west coasts.

The Feijoa in the West Indies

So far as known to the writer, the only point in the West Indies where the Feijoa has been grown for any length of time is at Columbia, Isle of Pines. Two plants set out by Dr. E. R. Ransdell in 1906 have made a growth of four feet in height and six feet in spread, but have not yet bloomed or fruited.

The Feijoa in Hawaii

At the Hawaii Experiment Station in Honolulu is a Feijoa several years old, which is reported by J. E. Higgins, Horticulturist, to be in a thrifty condition, but has given as yet no indication of fruiting.

The Feijoa has not been tested for a sufficient length of time in Florida, the West Indies, and Hawaii, to fully determine its adaptability to these localities, but experience seems to indicate that strictly tropical conditions such as are suited to the mango and the pineapple are not so well suited to this fruit.

The Feijoa in South America

In regard to the Feijoa in its native country, the following notes kindly furnished by Dr. J. Arechavaleta, Director of the National Museum at Montevideo, Uruguay, are of interest: "This plant is known here under the name of 'guayabo del pais.' Regarding its occurrence in a wild state in Brazil, Argentina and Paraguay I have no exact data, but in Uruguay it is quite common in the forests. It

Figure 92. Feijoa trained against a wall at Villa Niobe, Golfe-Juan, France.

is cultivated on an extremely small scale. It flowers in November and ripens its fruit in January and February. By cultivation the fruits are greatly increased in size. They are aromatic and of a flavor very agreeable to the taste."

Prof. Carlos Thays, Director of the Botanic Garden at Buenos Ayres, Argentina, gives the following notes: "This plant is found commonly, in the wild state,

in western Paraguay, in southern Brazil, and in some parts of the Territorio de Misiones, Argentina. The common name is 'guayabo.' The fruit is used for the manufacture of 'dulces' (i. e., jams, jellies, etc.) and is mixed with those of the Psidium (guava). * * * Cultivation for improvement of the fruits is very limited."

Methods of Propagation

BY SEED: While there are several methods by which the Feijoa may be propagated, the majority of plants, both in Europe and California, have been grown from seed. Propagation is readily effected by this means, in fact it has been found in France that when the fruits which fell to the ground were allowed to lie until spring, a large number of volunteer seedlings would spring up.

It is well to emphasize the point that when best results are desired, it is absolutely necessary to use great care in the selection of seed. Much disappointment has resulted in the past from the planting of seeds from inferior fruits. Plants for seed should be selected with a view to desirability in every character, not only in the size and quality of the fruit, but in precocity of bearing, and productiveness as well. Propagate from those plants which possess all these characters in as great a degree as possible. It is not a matter of planting seeds from an extremely large and fine fruit, which may have come from a plant whose bearing habits were very poor, as the seedlings would be very likely to perpetuate this undesirable characteristic.

The seeds are but slightly larger than those of the fig, and for this reason, although they germinate readily, they should be planted with care and given the best of attention.

For starting the seeds a good medium has been found to be a mixture of two-thirds clean sand, and one-third redwood sawdust. Both these materials are easily obtained. This provides a practically sterile mixture in which there is little danger from the fungus known as "damping-off." The sawdust should be kept wet and allowed to rot for two or three months before it is used.

The seeds should be sown in flats three or four inches in depth, and covered with the mixture of sawdust and sand to a depth of not over one-fourth of an inch. They may be planted quite thickly, if they are promptly pricked off after germinating.

It is best to plant the seeds as soon as possible after their removal from the fruit. If kept dry, however, they will retain their powers of germination for several weeks at least, probably longer, but it has not yet been determined just how long they may be kept and still give a good rate of germination.

If the seeds are started under glass, germination will take place in twenty to twenty-five days. If no artificial heat is provided, a somewhat longer period will be required, but not over four or five weeks at most.

Waterings should be frequent, but not copious. As soon as the plants have made their second leaves they may be pricked off into flats, or potted into two-inch pots, preferably the latter. When they have attained a height of three or four inches in the twos, they should be shifted into threes, where they can be

carried until they have reached a hight of ten or twelve inches, when they are ready to go out into the field.

M. Clement Nabonnand of Cannes, France, a noted rosarian and horticulturist, who has been very successful in raising the Feijoa, and to whom I am indebted for much valuable information, gives the following account of his method: "Provide some good leaf mold, preferably that gathered under trees in the forest. It must be thoroughly decomposed. Mix the leaf mold with equal parts of clean sand, and sow the seeds upon this compost, covering them to a depth of three-eighths or one-fourth of an inch, with the same material. Either boxes or clay pans may be used, and they should be placed in glass-covered frames, quite close

Figure 93. A large Feijoa at Golfe-Juan, France. On the left, M. Clement Nabonnand, one of the noted rosarians and horticulturists of Southern France; on the right, M. Amalberti, Dr. Andre's head gardener.

to the glass. It is necessary to have the glass whitewashed so that the young plants will not be burned. See that the soil is constantly kept slightly moist. Do not raise the sash until after the seeds have germinated."

By Cuttings: From the many attempts which have been made to propagate the Feijoa from cuttings there have been varying results. But judging from the sum of past experience, it will be no more difficult to grow this plant from cuttings than it is many other hard-wooded shrubs which are commonly propagated by this means. In many of the Botanic Gardens in Europe the Feijoa is considered not at all difficult to grow from cuttings, and several of the French gardeners have also been very successful. In California several attempts to root cuttings have resulted unsuccessfully, but this would imply a lack of proper knowledge on the

part of the operator rather than any inherent difficulty in propagating the plant in this way, since we know that it can be, and has been, done in Europe.

It is essential, if the cuttings are to be rooted at all promptly, that bottom heat be supplied, and that the work be carried on under glass. There has been little difficulty in rooting the cuttings when these two conditions have been recognized and supplied. The cuttings should be made of half-ripened wood—that from the ends of the branches, and three or four inches in length. It is probably not essential that the cuttings be made at any particular season, but it has been advised to do the work during June, July or August. The time required for the formation of roots is longer than with many other plants, and a greater percentage of cuttings may be lost, but under favorable conditions a good percentage has been successfully rooted.

A rather novel method of rooting cuttings of the Feijoa as well as other hard-wooded shrubs, is that practiced by Mr. Stewart, foreman of the glass department of the Royal Botanic Gardens at Edinburgh, Scotland. This method as discovered and successfully practiced by him has been named the Stewart Sun Method, and although the difference in climatic conditions will necessitate its being modified considerably in California, it should prove of great assistance in perfecting a method of quickly and successfully rooting Feijoa cuttings in this climate. The cuttings are placed in pure sand in a glass-covered box and placed in full sun. The heat inside the box becomes intense, so much so that an amateur would expect the cuttings to be promptly killed; but if they are kept liberally supplied with water—during hot weather they must be watered every half hour—they will form roots within ten days. Shrubs that are considered impossible to be propagated from cuttings Mr. Stewart has successfully rooted by this method, and those that ordinarily require two or three months to form roots can be struck in ten days.

BY BUDDING: Attempts to bud the Feijoa do not seem to have resulted successfully up to the present time. Many propagators consider the wood too hard and dry to bud successfully. However, the fact that guavas can be budded leads to the belief that the Feijoa can be budded as well. Both patch and shield budding have been found to be practicable with the guava, and it is quite reasonable to believe that one of these methods will be practicable with the Feijoa.

BY LAYERING: This is the simplest method of asexually propagating the Feijoa. By it the majority of plants in Europe, other than seedlings, have been grown. It requires no skill on the part of the operator, and though not so desirable for nursery work, it is an almost infallible method, and can be practiced to advantage by those who have a superior plant and desire to propagate it.

Layers may be rooted either in the ground, or in flats of soil supported by a platform erected close to the bush. In layering in the ground it is only necessary to bend down those branches which are most easily brought to the position, make a shallow cut at an angle, on the branch, and cover a portion of the branch including the cut, with soil to a depth of two or three inches. A small trench should be dug for the purpose at the most convenient place, and if necessary the branch may be held down with wire or wooden pegs. The layers require no further care

except to see that the soil is kept reasonably moist, and at the end of six months roots will have formed, and the plants can be severed from the parent.

In layering in flats supported by a platform, the operation is the same. The soil should contain plenty of humus, and be watered as often as necessary to keep it moist.

By Grafting: This method of propagation has not been extensively practiced but has been found to be successful. So far, the work has been done exclusively under glass. The stock used has been seedling Feijoa, of a diameter slightly less than that of a lead pencil. Both whip-grafting and veneer-grafting have been employed with equal success. The scions should be of about the same diameter as the stock, and the operation should be performed during March and April or

Figure 94. A ten-year-old Feijoa on place of Walter Nordhoff, at Redlands, California.

August and September. After the graft has been made, the plants must be kept under bell jars or in a tight glass frame, to exclude the air as far as possible, for a week or more. It is likely that some other myrtaceous shrubs or trees may prove more desirable for stocks than seedling Feijoas. Dr. Trabut of Algiers suggests *Eugenia jambolana,* on account of its hardiness and vigor.

By Inarching: The Feijoa lends itself readily to inarching, but this method is too slow and laborious to permit of its being widely practiced where any other is successful. Layering gives the same results with less labor, and cuttings should be more expeditious than either.

Inarching may be practiced advantageously upon seedlings in pots, by placing them upon a platform erected around the tree it is desired to perpetuate. A branch of the tree of about the same diameter as the stem of the seedling should be chosen, and a thin slice of bark, taking as little of the wood under it as possible, removed from both the stock and scion. The two cut surfaces should then be bound together with raffia or other soft tying material. After two months have elapsed, the scion may be gradually severed from its parent by cutting away a little of the wood just below the point of union, every few days. Care should be taken that the union is not severed too suddenly—it should be a month or two before it is entirely severed. The stock may then be trimmed down close to the union, and the plant is ready to set out.

Climatic Requirements of the Feijoa

At this date it is impossible to make a completely definite statement as to the different climatic conditions under which the Feijoa will thrive. The meagre data that is obtainable regarding its behavior in tropical countries is not sufficient by any means to prove that it will be a failure under such conditions as obtain within the tropics; still, there is no doubt but that a climate like that of Southern California is more eminently suited to it. Dr. Andre remarked that the native home of the Feijoa was the region of *Cocos australis*, which sufficiently indicated the climate in which it would thrive. It is, then, distinctly sub-tropical in nature, and can be expected to do well in localities whose climatic conditions closely approximate those of Uruguay and southern Brazil. Furthermore, the fact that it is a success in the Mediterranean basin shows that it is considerably hardier than the majority of subtropical plants which are in cultivation, and will thrive in localities where the avocado and other fruits more strictly tropical in nature can not be grown.

Whether it is adapted to desert regions such as the Colorado and Imperial valleys cannot be stated at this time, but the fact that it does well at Redlands indicates that it will tolerate a considerable amount of heat.

The Pacific Coast is pre-eminently adapted to the Feijoa—its successful cultivation at many points from San Diego north to the state of Oregon prove this beyond the possibility of a doubt. And the fact that it has withstood without injury temperatures of ten degrees above zero warrants the belief that it will be a success in the milder portions of the Gulf States.

Culture

While the Feijoa cannot be said to be particular in its cultural requirements, yet best results in both growth and fruit can only be obtained by giving careful attention to the needs of the plant and supplying them in as great a degree as possible.

In California the Feijoa has been successfully grown in soils of at least two kinds—sandy loam and heavy clay or adobe. And while it has succeeded in both, there is little doubt but that the lighter soil is the best. And it is of paramount importance that the soil contain an abundance of humus. Alfred Rivier of Marseilles, one of the most successful French growers, believes many failures in that country

are due to the presence of too much chalk in the soil, and advises as a remedy a small amount of iron sulphate worked in around each tree. He emphasizes particularly the importance of a light soil and an abundance of humus.

That the Feijoa is drought-resistant has been thoroughly demonstrated. A ten-year-old plant in Dr. Franceschi's garden at Santa Barbara has never had a drop of water except from the skies, and yet it has made a fair growth and is bearing regularly. And while the fruit grown without irrigation is probably of very fine flavor, it is probably not advisable to subject the plant regularly to such severe conditions. A liberal supply of water during the first few years results in much greater growth and more fruit. After the fifth or sixth year a large

Figure 95. Showing an eight-year-old example of the upright type of Feijoa raised by Mrs. J. Murietta in Los Angeles.

amount of water is not required, but for best results it is necessary to irrigate the Feijoa as frequently as citrus fruits. During the blooming season water should be withheld as much as possible, and until after the fruits have set, when it may be applied liberally to assist in the development of the fruits.

Fertilizers of all kinds must be applied with caution, or they will stimulate the growth of the plant at the expense of the fruit. A small quantity of bone meal, or some other form of commercial fertilizer not too rich in nitrogen, may be advantageously applied each year, as it increases both the quantity and size of the fruit. Well rotted manure can be used to supply the much-needed humus, and should be used liberally, but any manure that greatly stimulates the growth of the plant

should be avoided, unless it is in the case of young plants which have not yet come into bearing.

Practically all Feijoas observed in Europe which have arrived at the proper age to bloom have flowered profusely, whether grown in the open ground or in pots in a conservatory. But there are some plants which bloom regularly that are habitually unproductive, and this condition appears to be due in the main to imperfect fertilization of the flowers.

French growers have tried to overcome this failure of the plant to fruit by hand pollination. The results have been varied, some stating that it has been eminently successful, others that it appeared to have no effect and the plants were as barren as before, but this may have been due in a large measure to lack of skill or knowledge of conditions on the part of the operator.

In California there are quite a few plants of mature size which are habitually unproductive, although blooming regularly. It scarcely seems probable that this condition can be due entirely to unfavorable soil or other cultural conditions, although these have an extremely important effect. As practically all of the unproductive plants are isolated specimens, it seems likely that the lack of foreign pollen may have much to do with the matter, and experience with a number of seedlings during the past few years bears out this belief. Some thirty seedlings, planted in a row, bloomed for the first time in 1911, at the age of two years, and every one set several furits and brought them to maturity, although it is quite common for the plant to fail to set any fruits for the first two or three years in which it flowers. An older plant in the same location did not set any fruits until the same year, though it had bloomed for two years previously, and was in a healthy condition.

But the fact that many isolated specimens are producing abundantly shows that the plant is naturally not dependent on foreign pollen. The difficulty may be due in many cases to a weakened condition of the plant, caused by unfavorable soil or culture, and it is probable also that it is due in some instances to atmospheric conditions. Certain it is that the culture of the plant exercises a certain amount of control over its productiveness. Those which are subjected to harsh treatment or unfavorable conditions are invariably sparse bearers.

There is little likelihood that any difficulty will be experienced from this source when several plants are grown together, and their cultural requirements are supplied to a reasonable degree.

The Feijoa requires but little pruning. A judicious use of the shears is of course necessary to keep the bush in good form, and when it is desired to train it to any particular shape a more liberal pruning may be necessary. But as the fruit is produced on the young wood, pruning of a mature bush must be done at the expense of fruit, although it will naturally result in increased size of those produced. As the bush is frequently of open and spreading growth, and inclined to be somewhat straggling in the young stage, it is necessary to prune sufficiently to make it shapely. This point should be kept constantly in mind and the shears not withheld from an unshapely plant. The tips of long shoots should be pinched out to induce the plant to branch and form a compact body. The fact that the

Feijoa is found in two distinct forms of growth, one upright and the other spreading, makes it necessary to prune according to the individual character of the plant, the spreading form requiring much more attention than the upright.

For permanent cultivation the plants should not be set closer than fifteen to eighteen feet. While it may not be desirable to let the bush spread to an unlimited size, this distance will be necessary when the plants are mature, if any cultivating is to be done between them. Andre recommended that the plant be grown against a wall. This is undoubtedly a good practice in countries where the weather is cold at the time of ripening, as the shelter of the wall and the heat reflected from it assists materially in ripening the fruits.

Seedlings will come into bearing at three or four years of age if good cultivation is given them. Plants propagated asexually bear somewhat earlier, two years being the usual age for layered plants. It is not known just how long the plant will continue in profitable bearing—Andre's twenty-two-year-old bush seems to be increasing rather than decreasing in production.

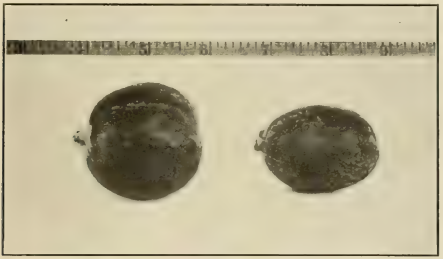


Figure 96. Showing variation in form and size among fruits from the same seedling tree. These probably represent bud variations.

Season

The season of ripening varies with different varieties, but can be said in general to be November and December. The Hehre variety matures much earlier, September and October being its season. The locality in which the fruit is grown also exercises a certain amount of control over the season in which it ripens, as would be expected.

In most instances the fruits fall when mature, but are not then ready for eating. They should be laid away in a cool place until they are in condition for use, which can be detected by their becoming slightly soft, and also by the odor, —a fragrance that is most delightful.

The fruits should be allowed to hang on the bush as long as they will do so, as they increase in size up to the moment they fall, and their growth during the last few weeks is much more rapid than at any other time. If picked before

fully mature they will ripen sufficiently to be eatable, but lack much of the delicate flavor which characterizes a perfect fruit.

There is usually considerable variation in size among the fruits, those which are the result of the latest blossoms never reaching their full development.

The Fruit and Its Uses

Very few people in California have as yet had an opportunity to taste the Feijoa. Those who have become thoroughly familiar with it, while invariably holding it in the highest esteem, are aware that there is a vast difference in quality among the fruits from different seedlings. And to be fully appreciated, the fruit must be eaten at just the proper moment. If allowed to become a trifle overripe, or if eaten a little before it is fully ripe, it lacks much of the delicate and aromatic flavor of a perfect Feijoa. Commenting on this point, Viviand-Morel says (Lyon-Horticole, XXXII, 1, p. 16): "Everyone knows that the finest pears are only turnips if eaten a trifle too soon or a trifle too late." And also, it has been found that the fruits produced by young bushes, as well as being inferior in size to those produced by a mature plant, are greatly inferior in flavor.

It is well to consider what some authorities have said of the flavor and value of the Feijoa. Dr. Andre, writing in the Revue Horticole in 1899, said: "I must slightly modify for the better what I said before (referring to his article of the previous year). The pulp is abundant, clear, of the consistency of a 'Butter Pear,' of a creamy white, and the savor approaches very much that of the strawberry, according to everyone who has tasted it. There are some seeds, but rare. The fruits, almost all falling slightly before maturity because of a damaging wind, were good. Their aroma was so intense that it filled the whole room in which they were placed, and the basket which held them is perfumed to this very hour."

Viviand-Morel says: "I find those that I have eaten pared, with sugar, delicious. I compare them in a certain measure to our large garden strawberries. The odor is very agreeable."

H. Dauthenay, writing in the Revue Horticole, says: "The flavor is slightly acid and very agreeable, rather vinous, and the odor something like that of the banana and also the strawberry. It is certainly a good exotic fruit to add to tables richly served."

These opinions of French authorities are quoted to verify the belief of all Californians who are intimately familiar with the Feijoa, that it is a fruit of rare merit. A few people have become prejudiced against it because of having sampled inferior specimens, but those who have been privileged to taste a perfect specimen, of which many have been grown in this state, have nothing but commendation for the Feijoa and confidence in its future.

The fruit can be used in many ways. Although it has been too scarce as yet to permit of much culinary experiment, delicious jams and jellies have been prepared, and when crystallized it is excellent. The French confectioners are experimenting with it for the preparation of bonbons. The general use of the

fruits in France is that mentioned above by Viviand-Morel,—pared, with the addition of a small amount of sugar.

Keeping and Shipping Qualities

Two strong points in favor of the Feijoa are its remarkable keeping and shipping qualities. Many fruits which have been grown in California have been kept in the house for three or four weeks, at the end of which time they were in perfect condition for eating.

As the fruits ordinarily fall when mature, and must be laid away for several days before in condition for eating, they can be shipped to a considerable distance and arrive in perfect condition, having ripened up in transit.

According to Alfred Rivier of Marseilles, the fruit can be kept from the time it is harvested, November or December, until spring, if stored in a cool, moist place. It is essential that the place of storage be cool, as otherwise the fruit will soon decay.

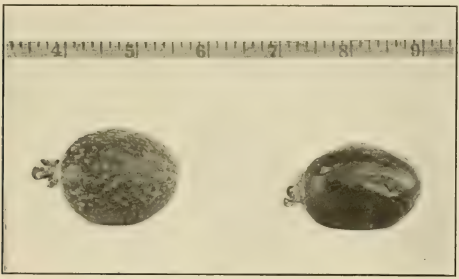


Figure 97. The Andre (at left) and Besson (at right) varieties, grown by Abel Gorre, at Menton, France.

Fruits have been shipped from France to California, and arrived in perfect condition after having been over a month in transit.

Diseases and Insect Pests

The hard, dry wood and tough, leathery foliage of the Feijoa render it almost immune from the attacks of insects or fungus growths. So far as has been observed, the only insect that attacks it is the Black Scale (*Saissetia oleae*), and instances of a thorough infestation of the plant by this species are extremely rare, even though Feijoas be planted in close proximity to other trees which are badly infested.

Variation and Varieties

With the Feijoa, as with practically all other cultivated fruits, the question of varieties is one of the most important that comes up for consideration. The

fact that this fruit has been in cultivation for but a few years, and that in this time no effort whatever has been made to obtain superior forms by either selection or breeding, shows that it is as yet practically in the wild state, and the question of varieties is still in an embryonic stage.

Andre did not, apparently, consider this question. At the time his plant came into bearing it was the only bearing specimen in Europe, so that no opportunity was given for comparison with others, and he makes no mention of having observed any marked variation among the plants in South America. Yet later writers have stated that among the wild plants in Uruguay there is a wide range of differences in form, quality and other characteristics.

Among the bearing plants in Europe it is possible to distinguish between two entirely distinct forms, and the minor variations exhibited by individual plants are almost innumerable. The only discussion of this subject, so far as known to the writer, is that made by Viviand-Morel (Lyon-Horticole, XXXII, 1, p. 16) in which he calls attention to the marked differences exhibited in a basket of fruits sent him by Abel Gorre of Menton, and discusses the subject at some length, but his data was not sufficient to enable him to reach any definite conclusions.

Of the first introduction to Europe, that of Dr. Andre, at least one hundred seedlings have been grown and fruited. These seedlings all exhibit the distinguishing characters of the parent to a greater or less degree, and even in the second and third generation these characters are maintained by the majority of individuals. Allowance must be made for an occasional "break," or departure from the type, but these seem to be less frequent than with most other fruits.

The second importation that was made to Europe was that of Besson freres of Nice, and consisted of seeds from Montevideo, Uruguay. This stock has proved to be of a distinct type from that of Andre, the seedlings uniformly exhibiting one or two characters that render the type immediately distinguishable from that of Andre.

In California, apart from the seedlings of the Andre type, which maintain their distinguishing characteristics here as well as in France, the only other distinct type, so far as known to the writer, is that originating in an importation of seed from Argentina made by H. Hehre of Los Angeles. Among the seedlings grown by Mr. Hehre, which were, in the main, not unlike those of the Andre type, was one which exhibited a peculiar characteristic, consisting of a marked departure in form from the normal. This variety has been named the Hehre. As yet it is impossible to say whether this characteristic is going to be transmitted to the progeny or not, but the variety appears to be much more vigorous than any other forms grown here thus far.

It is thus seen that three separate importations from South America have produced different types of fruit.

In general, it may be said that seedlings perpetuate the characteristics of the parent. But the fact that different types exist in South America shows that the species is as variable as most other tree or shrub fruits, and the matter of varieties must be given attention. Among the seedlings grown in California and

Europe the variations are many, but these are ordinarily so slight that it is not advisable to consider them as distinct varieties and establish them as such, or the subject would be involved in needless confusion. While among the seedlings of the Andre type there are many that are inferior to the original, and many which are slightly different from it in form and other characteristics, in general they approach the type so closely that they could not be considered as varieties. And it is noteworthy also, that the variation among fruits on the same tree, presumably due to bud variation, is so great that it is necessary to distinguish the variety by only those characters which hold good in the majority of the fruits produced.

Key to the Varieties

A. Form oblong to round.
  B. Surface more or less rough; usually self colored; size large. *Andre*
  BB. Surface smooth; one side overspread with red or maroon; size small to medium. *Besson*
AA. Form slender pyriform. *Hehre*

Figure 98. A seedling of the Andre at Marseilles, France.

Andre

(Figures 97 and 99)

The origin of this variety is unknown. It was brought as a layered plant from some point in Brazil, Argentina or Uruguay to France in 1890, by Dr. Edouard Andre. It is one of the largest of the varieties and is excellent in every respect.

Description: Form oblong to oval; size large; base rounded, sometimes slightly flattened; cavity none; apex rounded, sometimes slightly flattened; calyx sepals large, cupped; surface more or less rough; color green; skin thin; flesh whitish, very thick, granular, pulp fairly abundant, juicy; seeds very few, small; flavor spicy and aromatic, distinctly resembling the pineapple and also the straw-

berry, strongly perfumed; quality very good; season November to December at Golfe-Juan, France.

Shrub exhibiting two principal forms of growth, upright or spreading, with many intermediate forms; growth very vigorous; foliage abundant, healthy; productiveness excellent. So far as known to the writer, this is the first description of this variety.

Besson

(Figure 97)

This variety is the result of an importation of seeds from Montevideo, Uruguay, made in 1899 by Besson freres, of Nice, France. While considerably smaller than the *Andre*, it is equally as fine in flavor, and its brighter color makes it more attractive in appearance.

Description: Form uniformly oval; size small to medium; base rounded; cavity none; apex rounded; calyx sepals small, recurved, cupped; surface smooth; color green, one side overspread with red to maroon; skin thin; flesh whitish, medium thick, soft, fine grained, pulp abundant, very juicy; seeds rather numerous, large; flavor very spicy, aromatic, similar to *Andre;* quality very good; season November at Nice, France.

Shrub exhibiting two principal forms of growth, as in *Andre;* growth moderately vigorous, open; foliage fairly abundant, healthy; productiveness said to be fairly good. This is the first description of this variety.

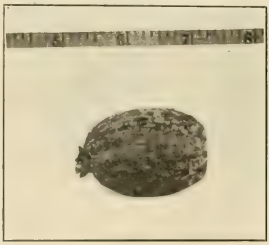


Figure 99. A fruit from the parent Andre tree, crop of 1911.

Hehre

This variety originated with H. Hehre of Los Angeles, California, from seed imported from Argentina. It is a distinct departure in form, but is probably of not as good quality as *Andre* or *Besson*. The variety is of exceptional vigor.

Description: Form slender pyriform, sometimes curved; size large; base tapering, slender; cavity none; apex slightly tapering; calyx sepals small, recurved; color yellowish green, self colored; skin thin and delicate; flesh whitish, finely granular, pulp abundant, very juicy; seeds rather numerous, large; flavor sweet, rather lacking in aroma, melting; quality fairly good; season September at Los Angeles, California.

Shrub upright; growth very vigorous and close; foliage abundant, large, healthy; productiveness fair. Here first described.

Plans and Plants for Small Places III

Slopes and Terraces

RALPH D. CORNELL
LONG BEACH, CALIFORNIA

We now come to that treatment of grounds whose irregularity of surface or relative position to the street makes terracing or sloping of the yard necessary; a difficult problem at its best. The terrace is naturally a part of the architectural scheme and should correspond with the house, forming, as it were, a broad, substantial foundation for the safe support of the dwelling. The ground should never slope directly away from a building, as that gives the structure a balancing,

Figure 100. Instead of the more formal terracing, natural slopes may be frequently used in very pleasing fashion.

unstable appearance. The width of the terrace, should, however, be determined by the size and style of the buildings and by the general sorroundings, as no fixed rules can be applied. The terrace should be given a slight fall to allow for drainage. Never permit it to have a hollowed or dished appearance, but rather crown it ever so slightly. If the size of the place permits, the terrace may follow the contour of the land, but in the small, city plot, the street is generally the determining factor for the line of conformity. Terraces should not end

Figure 101. Showing three different uses of terraces of verdure in breaking an abrupt height.

Figure 102. Originally an uninviting swale, this is now a beauty spot with its terraces and graceful trees.

abruptly, but should be given a gradual, convex-concave slope which allows of greater ease in watering and mowing, aside from the fact that it makes a more pleasing impression upon the mind of the observer. Neither should the terrace form an abrupt angle with the front walk, but should slope down gradually, nearing a level as it approached the walk. Where the steepness of the grade makes this impossible, it is often necessary to construct a retaining wall of masonry at the edge of the lot. Clinging vines, planted at its base, will soon cover the stonework, greatly softening and beautifying its appearance. It is well to avoid climbers of the bright flowering sorts as subdued colors create better harmony with the dull tone of the wall.

Figure 103. Showing successful treatment of a difficult problem in grading.

Let me here state that the heart and essence of success, in any line of work, is to fully grasp the situation that is before one; understand, in detail, the conditions as they exist, and then to determine the method of procedure best suited to the conditions *before any actual work is begun*. Too many home sites are spoiled by haphazard grading and planting, and by failure on the part of the designer, to fully grasp the situation with its possibilities and limitations, before beginning his work.

Simplicity is the key note of perfection. Let the grading, as well as the planting, be done as easily and naturally as possible. By that, I mean, not to expend unnecessary energy and expense attempting to alter natural conditions and thus create an artificial appearance; but to utilize the suggestions that nature

Figure 104. There is a satisfying harmony here between the stone retaining wall and the old style architecture.

Figure 105. The conditions of a large house near the street and a difficult piece of grading, have been met here in rather formal but very satisfactory fashion.

has already presented, and by reason and sense of fitness to blend, as artistically as possible, the artificial with the natural. Follow the line of least resistance. One cannot create a natural landscape upon a fifty foot lot; but what he does create can be made a much more harmonious portion of the surroundings than is often displayed.

Again, simplicity in planting is much to be desired. Especially is this true in Southern California, where the vegetation needs so little encouragement from man to form a jungle of foliage and color. Were climatic conditions such as to retard plant growth, so much emphasis upon this phase of planting would be unnecessary. A small variety of common plants, thoughtfully arranged, is far

Figure 106. Showing conditions similar to those in Figure 105 but with still more formal treatment. An addition of background on the right as on the left would greatly improve this place.

more pleasing than a florid group of antagonistic novelties all fighting for personal recognition. Unusual plants, if harmoniously grouped in proper environment, so as to lose something of their individuality, become indispensable in landscape art, but the individual should be sacrificed for the benefit of the whole.

Terraces should be devoted largely to lawn. The plantings, as on level spaces or uniform slopes, should be grouped along the sides and at the rear, leaving the central view open. On a small place, of any description, shrubs or dwarf trees should be used largely to the exclusion of tall growing trees, which because of their size, give a cramped, over-grown appearance to the yard, and often exclude sunlight, becoming an obstacle to perfect sanitation.

Terraces belong to formal gardening and, for the ordinary home, should be avoided. A gently sloping or rolling lawn is far more restful and natural in appearance than one built of enormous grass-covered steps, and should be given the preference, except in formal styles. Where the home is built on a rugged hillside, as is often the case in our rough districts, the grading and planting should be given especial consideration. Terracing becomes absolutely necessary in many cases, and often masonry is required. Personally, the writer does not favor stone work except as it becomes an unavoidable part of the construction; and then he would clothe it in clinging vines and soften its angles by shrubbery.

Steep banks can often be treated to great advantage by a covering of Mesembrianthemum, Vinca, ivy geranium or any of the numerous trailing things that love to spread over the ground unmolested. Such a treatment is far superior, in the mind of the writer, to a formal retaining wall that reflects the heat and constantly reminds one of the architectural skill needed for its construction.

The Hendersonia Disease of Eucalyptus Globulus

A. R. DAVIS
POMONA COLLEGE, CLAREMONT, CALIFORNIA

As far as the writer has been able to ascertain there have been no species of the genus *Hendersonia* as yet described on California eucalypts. Prof. Smith, pathologist of the State Experiment station at Whittier, makes mention as far back as 1909 of a *Hendersonia* on *Eucalyptus globulus*, but beyond a few words as to its minor importance as a parasite, does not describe it. The fungus herein worked out is probably the same as that observed by Prof. Smith and others, although we cannot of course be certain. There are a number of fungi on this particular species of eucalyptus and many of them are as yet undescribed; some are parasitic, most of them fortunately saprophytic in their mode of life. With

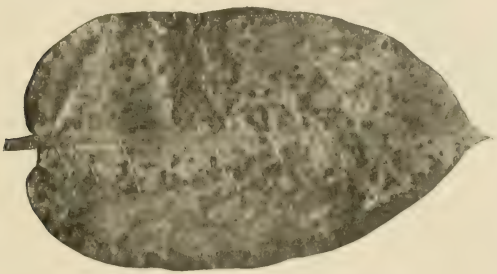


Figure 107. Leaf of Eucalyptus globulus affected with Hendersonia.

the *Hendersonia*, however, there is hardly a doubt as to its parasitic tendencies; a detailed cultural study was made of it, its method of germination, growth of hyphæ, re-inoculation of healthy leaves, etc.

The fungus is distributed over quite an area in Southern California, the full extent of which cannot be fully known until further observations are reported. Of a number of trees in and around Claremont the writer has found but few that were not affected to a greater or less extent. The damage actually done by the fungus seems at present to be slight. It confines its attack exclusively to the young, broad leaves, breaking down the leaf tissue and thus preventing a flow of sap. Deprived of its food, the leaf soon dies and falls off. This latter is only true in extreme cases of infection. After the tree has passed the broad leaf

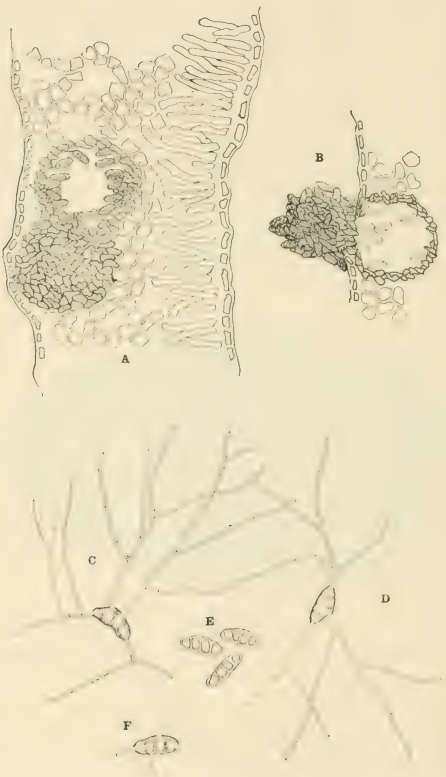


Figure 108. A, section of leaf showing pycnidia of Hendersonia still enclosed; B, the pycnidia erumpent and giving out the adherent hypophyllous spore mass; C, D, F, germinating spores; E, showing the thick walled spores.

stage and develops tougher and longer leaves it is, as far as I have been able to observe, immune. The infection has been found to be especially noticeable upon the tender leaves of the shoots and sprouts from old eucalyptus stumps and here perhaps it works its greatest damage. There have come to my notice such shoots twenty feet in height on which there seemed not to be a single leaf that has escaped the infection. Many of the leaves had turned yellow except where the great blotches of diseased tissue were bearing their harvest of countless spores. In a five acre Blue Gum stand just south of Claremont there was not a tree to be found on which the young leaves were free from the fungus. In spite of this general infection the actual damage caused was not great. The number of young, broad leaves were few in comparison to the tougher ones and the trees did not seriously miss their failure to function.

The infection probably takes place through the stomata on the under side of the leaf and with the spread of the mycelium the leaf tissues are killed. The presence of the fungus is first noticed by the appearance of small circular or irregular purplish-brown patches on the lower epidermis. As the mycelium spreads the diseased area extends from epidermis to epidermis and in case of bad infection the areas merge together in large irregular shaped blotches. In the older spots the color of the center changes to grayish-brown, while the edge retains the characteristic purplish-brown marking. At this stage the pycnidia are formed just beneath the lower epidermis (Figure 108 A). The pycnidia are black granular bodies, globular in shape and ranging in diameter from .06 to .12 mm. They appear at times in pairs and again solitary. In one small diseased area 1 mm. across occurred ten of these pycnidia in all stages of development. At times they attain large size extending fully three-fourths the distance through the leaf, crowding and distorting the palisade cells. The pycnidial wall is made up of a rather thin but quite tough granular membrane (Figure 108 A).

The spores vary noticeably in size though but little in their general shape (Figure 108 E). They are borne upon short, simple, hyaline sporophores (Figure 108 A) ranging from 6 to 10 microns in length. The spores themselves vary in size from 8 to 11 by 22 to 32 microns and have three transverse septa, the wall of the spore being depressed at each septum. In color they are olivaceous to smoky brown.

When the pycnidium is mature the epidermis is ruptured and the spores emerge in a compact, naked, black mass which adheres loosely to the epidermis, and these masses are noticeable as minute black dots upon the surface of the diseased area (Figure 108 B).

This apparently undescribed species may be called *Hendersonia eucalypticola.*

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II MAY 1912 Number 2

The Palms Indigenous to Cuba, I

ODOARDO BECCARI
FLORENCE, ITALY

The palms that up to the present day are known to grow wild in Cuba and in the small islands, its dependencies, amount to twenty-five species. Of these only two belong to the tribe of *Cocoineae*, and six to that of the *Arececae;* the greater bulk of the remaining species being furnished by the *Corypheae*. This fact shows, I think, that the Cuban palms are derived only in very small measure from the southern part of the American Continent, for there the *Corypheae* are very scantily represented, whereas almost all the members of the *Cocoineae* are native to South America. The Cuban *Areceae*, however, show affinities with species or genera growing on the continental shores of the Caribbean Sea. On the American *Corypheae* I have already published a study,* where I make it evident that the Cuban palms belonging to this tribe are mostly related to and at times quite identical with, species growing in Honduras, the Yucatan peninsula, in Texas, and Florida.

The most peculiar of the Cuban palms is certainly the *Pritchardia wrightii*, not only because of its affinity to its remote parents in Hawaii, but also on account of its singular bottle-shaped stem, which is very well shown in one of the fine photographs taken by Prof. C. F. Baker in Cuba. And indeed it has been the desire of publishing this fine set of pictures, which so well illustrate the palms inhabiting the largest island in the West Indies, the "Regina Antillarum" to use the words of Grisebach, that has induced me to undertake the present study. Moreover, I hope that this small contribution to the knowledge of the Palm Flora of Cuba will stimulate fresh researches into, and the collecting of new herbarium specimens of those species, which are as yet imperfectly known, or of which the precise habitat is uncertain, as for the most part are also those gathered by Wright in the east of the island.†

---

*Le Palme americane della Tribù delle Corypheae in "Webbia" di U. Martelli.—Firenze Vol. II (1907).

†Prof. Asa Gray in the Introduction to the "Plantæ Wrightianæ" in Mem. Acad. Amer. Scient. etc. N. Ser. v. VIII (1860) p. 153, gives the following information: "The specimens were mainly gathered in the high country and mountains behind Santiago de Cuba and Cobre (mostly within a moderate distance of Filantropia, the

Cocos nucifera is also frequently met with in Cuba; about this palm Mr. O. F. Cook writes: "Columbus himself recorded the finding of coconuts on the north coast of Cuba, near Puerto Principe, only a little over a month after his first landing in the Bahamas,"‡ an assumption, however, which in my opinion is open to serious objections.

It is a remarkable fact that amongst the twenty-five palms indigenous to Cuba, three of them (*Oreodoxa regia, Acrocomia fusiformis, Pritchardia wrightii*) perhaps even a fourth (*Pseudophoenix vinifera?*) possess bulging or fusiform trunks, whereas amongst the several hundreds of species inhabiting the Old World, only two or three are endowed with this peculiarity. Other Cuban palms are noteworthy for the great mass of roots at the base of their trunks, but this is a far more common phenomenon than the bulging of the trunk.

These deviations from the normal and more common structure in palms, has suggested to me some observations, which I hope will not be found quite out of place, as an appendix to the systematic part of this study.

For the present monograph of the Cuban palms I have been able to study a rather extensive material, for which I am largely indebted to Prof. C. F. Baker; other valuable specimens I have found in the Herbarium de Candolle. But I must especially thank Prof. I. Urban for the loan of the entire set of palms gathered in the Caribbean Islands by numerous collectors, forming part of the Herbarium Krug and Urban, and now incorporated in that of Berlin.

Conspectus of the Genera

I. Leaves pinnate, pinnatisect, or simply pinnately veined.

Tribe I—ARECAE

Ovary 1-3 celled. Fruit with 1-3 seeds; endocarp membraneous, fibrous, or thinly woody; not marked by pores on its outer surface.

1. Female flowers with valvate petals, more or less united in their basal part.

a. Flowers in groups of 3, one female between two males, at least in the lower part of the branchlets. *Oreodoxa*

aa. Flowers pediccllate in small bunches at the end of the branchlets. Male flowers numerous. Female flowers few, having the perianth smaller than the male ones, but equally well developed stamens. *Pseudophoenix*

aaa. Flowers approximate in linear groups of 2-5, one above the other, of which the lowest is usually female and the others male. *Gaussia*

2. Female flowers with imbricate petals.

a. Male flowers with 6 stamens having free filaments. *Euterpe*

---

hospitable country residence of George Bradford, Esq.) and especially in the elevated district back of Santa Catalina de Guantanamo, where the collector's principal station was Monte Verde, a coffee plantation, residence of the most estimable and hospitable M. Lescaille; from which place, as a centre, Mr. Wright is still prosecuting and extending his herborizations."

‡History of the Coconut Palm in America, in Contrib. U. S. Nat. Herb. v XIV. II., p. 280.

aa. Male flowers with 6 stamens, the filaments united to form a columnar body within the corolla, free and radiating above, anthers sagittate.
Calyptrogyne

Tribe II—COCOINEAE

Ovary 3 celled (in the species here described). Fruit with 1-3 seeds, often 1-2 of the cells obliterate; endocarp bony, marked by 3 pores, each corresponding to the position occupied or which ought to be occupied (morphologically) by the embryo in the cells.

a. Flowers in numerous glomerules of 3, one female between two males, at least in the lower part of the branches. Female flowers having a gamopetalous corolla. *Bactris*

aa. Female flowers considerably larger than the males and placed on the lower part of the branchlets; corolla with imbricate petals. Male flowers in notches, approximate in the upper part of the branchlets. *Acrocomia*

II. Leaves flabellate, and radiately divided (never pinnate).

Tribe III—CORYPHEAE

Sub tr. I—Eucorypheae

Ovary formed by 3 carpels, free from the base, or more or less united together.

a. Ovary formed by 3 carpels, completely united together, and with 3 distinct uniovulate cells. The fruit usually formed by the development of only one cell and with the remains of the style lying close to its base. Leaves with unarmed petioles. *Sabal*

aa. Ovary formed by 3, more or less independent carpels.

1. Petiole more or less spinous on the edges. Seed with homogenous albumen. *Acoelorhaphe*
2. Petiole spinous on the edges. Seed with ruminate albumen. *Copernicia*
3. Petiole smooth on the edges. Seed with homogenous albumen. *Pritchardia*

Sub. tr. II—Thrinaceae

Ovary formed by a single carpel, unicelled and uniovulate.

a. Seed having an even surface; albumen equable but penetrated from its basal part, more or less deeply, or even completely transversed, by an intrusion of the integument.

b. Stamens 6 with almost sessile reversed anthers. *Hemithrinax*

bb. Stamens 6 (or 5-7), with slender subulate filaments. *Thrinax*

aa. Seed marked by 5-6 vertical grooves and more or less distinctly lobed-cerebriform. *Coccothrinax*

OREODOXA Kunth

(Non Willd.) Kunth in Humb. et Bonpl. Nova gen. et sp. Pl. I, p. 244, edit. min. p. 305 (1815); Mart. Hist. nat. Palm. III, p. 166. *Roystonea* O. F. Cook in Bull. Torrey bot. Club, 1901, p. 549.

For the old and familiar name of *Oredoxa* Mr. O. F. Cook (Bull. Torrey bot. Club, 1901, p. 549) has substituted that of *Roystonea*, on the ground that the type of the genus *Oreodoxa* is *O. acuminata* of Willdenow, a palm referred to *Euterpe* by Wendland, but which, according to Cook, is the type of a distinct genus, for which the name of *Oreodoxa* must be maintained.

Wendland has recognized Willdenow's *O. acuminata* in the flowering specimen of a palm, collected by Moritz at Tovar in Venezuela (N. 1670 in the Berlin, Herb.) My own independent researches have led me to the same conclusion, with regard to a fruiting specimen, collected by Fendler (n. 2462 in Herb. de Cand.) also at Tovar, and consequently in a region not remote from Buenavista, from whence came the original specimen of *O. acuminata* (Figure 109).

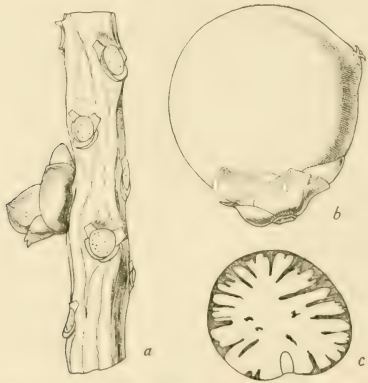


Figure 109. Euterpe acuminata. a, portion of a fruit-bearing branchlet; b, fruit; c, seed cut longitudinally through the embryo. (From Fendler No. 2462).

The above mentioned Fendler's specimen corresponds exactly to the description of *O. acuminata* given by Willdenow, and most certainly belongs to a typical *Euterpe*, having the seed with a ruminate albumen. Now as the genus *Euterpe* Gaertner is very well identified at present, as I shall demonstrate later, when speaking of this genus, and as this genus was published in the year 1788, and *Oreodoxa* Willd. in 1804, the name of *Oreodoxa acuminata* was rightly changed by Wendland to that of *Euterpe acuminata*, and accordingly the name of *Oreodoxa*, applied to *O. regia* by Kunth, remains unattached.

The accurate study I have made of the Cuban *O. regia* has led me to make a rigorous revision of all the other members of the genus *Oreodoxa*, which I consider to be composed of the following species only:

Conspectus of the Species of Oreodoxa

Male flowers having, when in bud, the stamens entirely enclosed in the corolla. Fruit globular-ovoid, more or less gibbous, not more than one-third longer than broad.

1. Fruit 11 mm. long, 9 mm. broad. Pericarp on the whole 1-1.5 mm. thick; mesocarp grumose when dry. *O. regia*
2. Fruit 13 mm. long, 10-10.5 mm. broad. Pericarp on the whole 1-1.5 mm. thick; mesocarp grumose when dry. *O. charibaea*
3. Fruit 17 mm. long, 13 mm. broad. Pericarp on the whole about 3 mm. thick, subinflate, the mesocarp being very lax when dry and, apparently, very juicy when fresh. *O. princeps*

Male flowers having the petals open, and with the stamens protruding beyond them long before the anthesis. Fruit oblong, more or less curved, nearly twice as long as wide. *O. oleracea*

Oreodoxa regia Kunth in Humb. et Bonpl. l. c.; Mart. Hist. nat. Palm. III, 168, t. 156, f. III, IV, V; Griseb. Cat. pl. Cub. 222; Sauvalle Fl. Cub. 153; Combs, in Trans. Acad. St. Louis, VII (1897) 471, Becc. Reliq. Scheff. in Ann. Jard. bot. Buit. II (1885) 147, t. 11; Sargent, Silva N. A., X, 31, t. DV; Hemsley in Biol. Centr. Amer. Bot. 401. **O. oleracea** (non. Mart) Griseb. Pl. Wright, 531 et Pl. Cub. Wright n. 1467,

Roystonea regia O. F. Cook, l. c. 531.

I do not think it necessary to spend many words in describing the general aspect of this palm, which is a favorite ornament in the tropical gardens of every part of the world. I have, however, to remark that the bulging of its stem cannot be absolutely taken as a specific character, witness Figure 110, which reproduces the Royal Palm in the wild state, growing in Western Cuba, and Figure 111 taken at Santiago de las Vegas. In both of these figures some individuals have stems almost regularly cylindrical from base nearly to summit, while others have a more or less fusiform appearance in the intermediate portion.

The Royal Palm is a rather variable plant, not only as to the bulging of its trunk, but also in regard to the shape, size, and small peculiarities of the fruit, and to some other small characters. On this account it exhibits several forms, difficult to define and apparently localized to the different regions where this palm grows. This is the case with the *Oreodoxa* of Porto Rico, which has been distinguished as a species (*O. charibaea*) but which, I think, would be much better considered as a simple variety.

O. regia is a very widely diffused palm, as it is not only frequently met with in the savannahs, and along streams and rivers in Cuba, especially in fertile soil, but is naturally dispersed in almost all the other Antilles; it is also found in Panama, where Hemsley writes that it is common about Cruces, Gorgona and San Juan.

The *Oreodoxa* growing in Florida was identified by Prof. Sargent (i. c.) as *O. regia*, but of this palm Mr. O. F. Cook has made an *O. floridana*.

O. regia is also reported from the Bahamas. (Gardiner in Proc. Acad. Phil. 1890, p. 358), (non. vidi).

Several notes about *O. regia* have been already published by me in the "Annales du Jardin botanique de Buitenzorg" v. II (1885), but I think it convenient to give here a detailed description of the Cuban *O. regia,* which may be considered as the type, for establishing its specific characters on solid bases.

The *leaves* of *O. regia* are very large, have an elongate leaf sheath, tightly enveloping the vegetative cone, and one after another drops off at every fresh

Figure 110. Oreodoxa regia growing on high, stony ground in Western Cuba in the shade of a huge ceiba tree. Note varying form of trunk.

emission of a spadix, leaving the trunk quite clean, but more or less distinctly ringed. The leaflets are alternately inserted in contrary ways along the rachis, and stand in four different planes, at least in its lower and intermediate part, but are more regularly set, and almost on one plane towards the end. The leaf-rachis is at first more or less sprinkled with small, appressed, orbicular, tobacco-colored, deciduous scales, and by age acquires a glabrous appearance.

Figure 111. Oreodoxa regia as it grows with aguacates and sapodillas in the rich Partidos tobacco district of Cuba.

The *leaflets* are firmly papyraceous, ensiform, quite straight and very gradually narrow above from below the middle, to a very acuminate, rather rigid, briefly bifid apex, generally more deeply split by age, they are attached to the rachis by a narrow base and have here the margins strongly reduplicate; they are green on both surfaces, but on the lower are rather densely sprinkled with very numerous, very small dots visible only under a strong lens; they have a strong mid-costa, very prominent above, and covered below by an almost continuous line of elongate chaffy scales; the secondary nerves are 2-3 on each side of the mid-costa; the tertiary nerves are very numerous and not very prominent; margins acute, not or very slightly thickened; transverse veinlets obsolete. The intermediate leaflets are 70-95 cm. long and 3.5-4 cm. broad.

The *spathes* are two; the exterior spathe is tubular, pervious at its upper end, considerably shorter than the interior one, which completely envelops the spadix before the anthesis, and is at that time flattened-fusiform and biconvex, later deciduous.

The *spadices* in number 3-4 are erect at the same time, when not yet open, at the base of the lowest leaf-sheath, are spreading when in flower, and when in fruit form dense subglobose panicles around the summit of the trunk, under the shade of the magnificent crown. The spadices have a very short, broad peduncular base, and are twice branched; the primary branches are conspicuously swollen at their bases and are divided into several alternate flowering branchlets; these are slender, terete, 1.5-2 mm. thick at the base, 15-25 cm. long or shorter, more or less sinuous between the flowers, and narrow very gradually above to a subulate apex; while still enclosed in the spathes they are covered by a curious kind of trichomes, formed by vesicular, acute cells, grouped at the end of a small, simple or branched, pedicel; after flowering the groups of vesicular cells are detached from their pedicels, and are dispersed in the form of a fine granular powder, while the pedicels remain to render the surface of the branchlets more or less puberulous-papillose.

The *flowers* are light colored even when dry, are ternate almost to the end of the branchlets and are inserted on very superficial flat orbicular pulvinuli. The *male flowers* are at all times considerably larger than the female, are irregularly ovoid, obtuse, 5-6 mm. long, 3.5-4 mm. broad; the calyx is very small, with slightly imbricate, scarious, subpellucid, subdeltoid, obtuse or acute, and more or less carinate, sepals; petals considerably longer than the sepals, concave, thinly pergamentaceous, irregularly ovate-oblong or oblong-elliptical, bluntish or subacute, striately veined, have internally at the base a nectariferous swelling. Stamens usually 6-7, occasionally 8-9, about as long as the petals also during the anthesis, about 5 mm. long on the whole; anthers relatively large, 3 mm. long, erect when in the bud, slightly shorter than the filaments, ovate-elliptical or ovate-sagittate, obtuse, the cells united by a broad conspicuous connective, dark colored in the dry state, inserted on the filament about their middle, from which the cells remain separated in their lower part; filaments 4 mm. long, linear subulate at apex, somewhat flattened; rudimentary ovary globose, with three short, acute, stigmatic points.

The *female flowers* open a short time after the male, are horizontal, 4 mm. long when full grown but not yet open, broadly conical and apiculate; sepals reniform, entire, smooth, slightly callous at their bases; corolla four times as long as the calyx, urceolate-campanulate when open, divided down to a little below the middle into three triangular briefly acuminate, valvate divisions; the staminodes form a cup, lining the undivided part of the corolla, and crowned by six obtuse lobes of which three peep forth between the divisions of the corolla; the lobes, which represent the filament, do not show usually any rudiment of the loges of the anthers, though at times faint traces of these may be found. Ovary globose, usually unicelled, with rudiments of the two other cells, more rarely with two of these perfectly developed, producing then a didynamous fruit; ovule attached along one side of its cell; stigmas fleshy, triangular-subulate, recurved.

Fruit globose-obovoid and somewhat gibbous, 11 mm. long, 9 mm. broad (when dry) or thereabouts, with a perfectly round top and with the remains of the stigmas placed a little above the base, on the less convex side; pericarp on the whole 1-1.5 mm. thick; the epicarp is smooth outside, thin and brittle in the dry fruit; the mesocarp is scanty, softly parenchymatous, and apparently slightly fleshy when fresh, grumose when dry; it has a layer composed of a few fibro-vascular bundles in its innermost part, which form a net work very adherent to the endocarp. The endocarp is thinly woody and forms a shell or putamen to the seed, and is 8.5-9 mm. long, 7 mm. broad, and its inner wall remains adherent to and almost connected with a large portion of the antiraphal side of the seed, but is brittle and removable on the side of the hilum; the putamen presents also on the median line of its antiraphal side a conspicuous vascular strand, which leaves on the seed a more or less distinct sulcus, at times, however, quite obsolete.

The *seed* is broadly ovoid-elliptical, rounded at both ends, slightly compressed and flattish on the raphal side, 7.5-8 mm. long, 7 mm. broad, 6 mm. thick; the raphal side is conspicuously marked by a circular central area in which, a little below the centre, is placed the hilum, whence numerous, very apparent, vascular ramose, whitish venations radiate. Albumen homogeneous, very slightly excavate on the raphal side, because of a very superficial thickening of the integument in that place, which corresponds to the external circular area spoken of above. Embryo, obliquely basal, penetrating deeply into the substance of the albumen. (Figure 112).

Fruiting perianth explanate, not accrescent. (Figure 112).

The description of the fruit given above is from the specimens numbered 3516 in the Herbarium C. F. Baker, which were collected near Santiago de las Vegas; that of the flowers from Curtiss n. 432, who gathered the specimens at Nuova Gerona in the Isla de Pinos. In these specimens the fruit is very slightly smaller than in those from Santiago de las Vegas, and the branchlets of the spadix are glabrous, whereas they are puberlous-papillose in those of the other locality. The specimens of the "Plantæ Cubenses Wrightianæ" (n. 1467) distributed under the name of *O. oreodoxa oleracea* are certainly *O. regia*.

Of *O. regia* I have examined the following specimens:

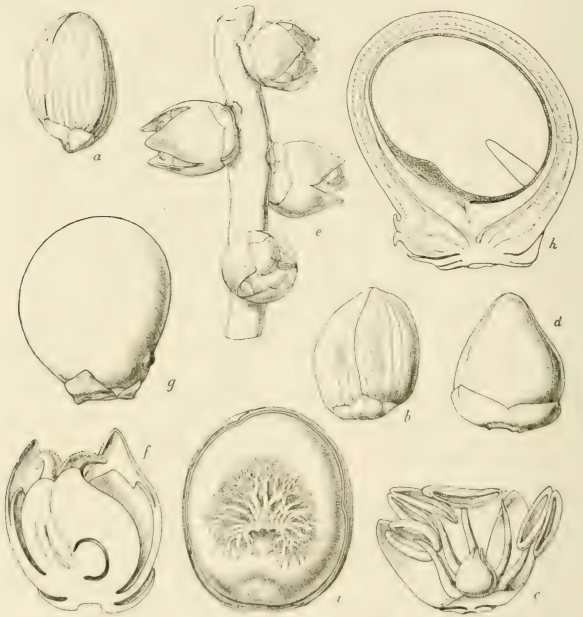


Figure 112. Oreodoxa regia. a, b, male flowers in bud; c, male flower during anthesis, from which one of the petals and two stamens have been cut out to show the interior; d, female flower in bud; e, portion of a flowering branchlet with female flowers during anthesis; f, female flower cut longitudinally; g, fruit, side view; h, fruit cut longitudinally through the embryo; i, seed seen from the raphal side (h and i from Baker No. 3576; all the other figures from Curtiss No. 432).

CUBA: Province of Santa Clara, district of Cienfuegos, Cieneguita, *Combs* n. 694 (Herb. Berol.) Neighborhood of Santiago de las Vegas, Prov. de Habana, *Wilson* n. 3516 (Herb. Berol. and Bece.) Near Nueva Gerona, Isla de Pinos, *Curtiss* n. 432 (Herb. de Cand.)

JAMAICA: Near Castleton, Aug. 1902, Herb. Bot. depart. n. 8, in Herb. Berol. (In these specimens the female flowers are almost globular and very slightly or not apiculate. The male flowers are slightly smaller than in the plant of Cuba (4-4.5 mm. long). The fruit as in the type, but with the intrusion of the integument more pronounced. (Figure 113, d, e, f).

S. DOMINGO: Mouth of the Yuna River, *Taylor* n. 61 (Herb. Berol.) Fruits as in the type from Cuba (12 mm. long, 9 mm. broad) but with the seed almost completely free from the inner wall of the endocarp; intrusion of the integument of the seed rather deep. (Figure 113, f).

ST. CROIX (Danish Antilles): *Rev. J. J. Ricksecker* n. 103 (Herb. Berl.) Apparently not different from the plant of Cuba.

PANAMA: Fruits indistinguishable from those of the Cuban specimens, but with the seed adherent to the inner wall of the endocarp over a very small area only.

Oreodoxa charibaea (Spreng) Damm. et Urb. in Symb. Antill. IV 129. **Roystonea Borinquena** O. F. Cook in Bull. Torrey Bot. Club, 1901, p. 552, t. 45 f. 2 a dextera. **Euterpe charibaea** Spreng. Syst. II (1825) p. 140 (excl. **Areca oleracea** Jacq.)

The type of *Euterpe charibaea* of Sprengel is apparently a specimen collected by Bertero in Porto Rico, but doubtless Sprengel also included in his diagnosis the characters of *Oreodoxa oleracea,* for he describes the fruits as "subincurvatis." I have examined one of Bertero's specimens in the Berlin Herbarium, and another in that of De Candolle; both consisting of small portions of the spadix with male and female flowers only. The male flowers have 6-7 stamens with anthers slightly larger than in the flowers of *O. regia* from Cuba. The female flowers have the teeth of the staminal urceolum furnished with sufficiently distinct anther cells; but little importance is to be attached to this character as rudimentary anther cells exist also in the female flowers of Wright's n. 1467 from East Cuba, whereas they are altogether absent in the flowers of the specimens coming from the opposite end of the island.

I have examined of *O. charibaea* the flowering specimens of Sintenis n. 1605, and the fruits numbered VII of the same collector (Herb. Berol.) and also complete specimens in flower and fruit from plants cultivated in the botanical Garden at Buitenzorg (Figure 113, a, b, c). The main differences between *O. charibaea* and *O. regia* consist in the fruit, which is somewhat larger in the first than in the second, and in the seed, which remains almost entirely free from the inner wall of the endocarp. The fruits in Sintenis n. VII are 13 mm. long, 10-10.5 mm. broad. In the fruits from the plants cultivated at Buitenzorg the intrusion of the integument of the seed into the mass of the albumen is considerably deeper than in

O. regia, and has the form of a cone with a broad base. This same character is offered by fruits I have received under the name of *Roystonea borinquena* by Dr. Francoschi from Porto Rico; this intrusion, however, is less pronounced in the fruits from n. 1605 of Sintenis, and in those of Sintenis VII is not more pronounced than in the seeds of *O. regia* from Cuba.

On the whole, *O. charibaea* is so closely related to *O. regia* that it seems to me only a geographical form of that plant, or in any case nothing more than a second degree species.

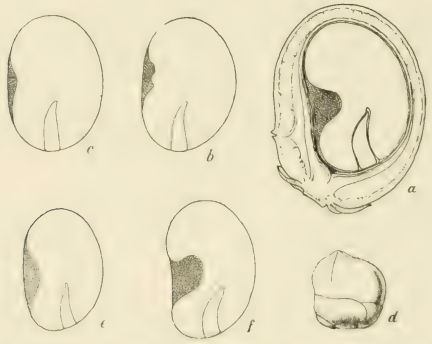


Figure 113. Oreodoxa charibaea. a, longitudinal section of a fruit (from a plant cultivated in the Botanical Garden at Buitenzorg); b, longitudinal section of a seed from Sintenis No. 1605; c, longitudinal section of a seed from Sintenis No. VII. Oreodoxa regia. d, female flower, and e, longitudinal section of a seed (both figures from the specimen No. 8, Bot. Dep. Jamaica); f, longitudinal section of a seed from a plant collected in S. Dominga (Taylor No. 61 in Herb. Berol.).

Mr. Cook has observed that on the roots of this palm exist tubercles, produced by bacterioids, analogous to those of the *Leguminosae* and other plants. The same kind of tubercles I have observed on the roots of another palm, the common *Trachycarpus excelsa*.

To *O. charibaea* is referrable the Genus *Ignotum*, Urban Symb. Antill. IV. 134; Sintenis n. 6512 in Herb. Krug et Urban (Berlin Herb.) collected at San André near Usuado in Porto Rico. The specimens consist only of very juvenile and tender flowering branchlets with flowers very imperfectly developed; the branchlets are entirely covered by the characteristic trichomes, which I have described in *O. regia*, and which has enabled me to settle the question of the identification of these specimens.

Oreodoxa oleracea Mart. Hist. nat. Palm. III p. 166 t. 156. f. 1, 2, et tab. 163; Becc. Reliq. Scheff. in Ann. Jard. bot. Buit. II 150 t. 12; Drude, in Mart. Fl. Bras. III, II, 474.

This species is peculiar to the smaller Antilles and is quite distinct from *O. regia* and its near ally, *O. charibaea,* not only by its quite cylindrical, never bulging stem, and by the curved, rather elongate fruit, but also by the quite different male flowers.

The stamens in the *male flowers* of *O. oleracea* spring beyond the corolla a long time before the anther cells are apt to open, and emit the pollen grains; perhaps they never remain entirely enclosed in the corolla, even when very young. On account of this circumstance the branchlets of *O. oleracea,* when covered with male flowers, as are those distributed by Glaziou under n. 8055, have an aspect quite different from those of *O. regia and O. charibaea.*

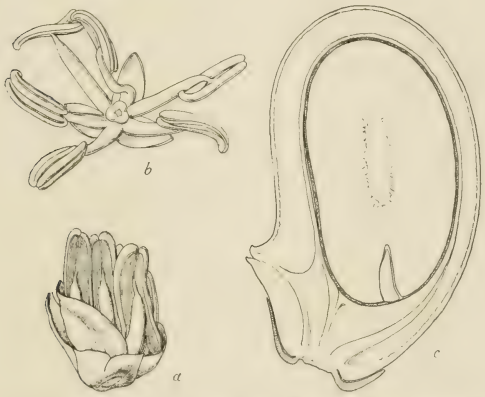


Figure 114. Oreodoxa oleracea. a, male flower before anthesis; b, male flower during anthesis; c, longitudinal section of a fruit.

The *female flowers* are globular, apiculate, similar to those of *O. regia;* the lobes of the staminal urceolum have rather distinct rudimentary anthers.

The *fruit* is oblong, slightly curved and concave on the side of the stigmas, it is 14-15 mm. long and 9 mm. broad; at complete maturity the mesocarp leaves the endocarp free, which forms a thin and fragile shell or putamen to the seed, and has an even, dull surface, upon which, however, the internal fibrous vascular net of the mesocarp remains adherent. The putamen has the general form of

the fruit, but it tapers a little towards the base, which is acute or shortly caudiculate. The *seed* is oblong-elliptical, 11 mm. long and 6 mm. broad, rounded at both ends, flattish or slightly concave on the raphal side, where two-thirds of its surface is covered by the oblong areola formed by the vascular ramification of the raphe; the hylum is linear. On the more convex or antiraphal side I have observed a small papillæform point about its centre, where at times the endocarp adheres to the testa of the seed; otherwise the seed remains entirely detached from the internal wall of the endocarp. The albumen is homogeneous, and without any intrusion of the integument. The embryo is slightly obliquely basilar. (Figure 114).

There is a rather good representation of this palm in "Descourtilz: Flore medicale des Antilles" v. IV (1827) plate 265, which is not mentioned by Martius.

The young flowering branchlets of *O. oleracea* are, when still enveloped by the spathe, covered by an abundant white cottony matter, which remains free when the spadix expands, and is composed of a very curious kind of trichomes, composed of inflated acuminate cells of the same nature as those existing in *O. regia*, but much more abundant, and with more elongate cells.

Of *O. oleracea* I have examined in the Berlin Herbarium complete specimens, collected by Père Duss in Guadaloupe (n. 4173), where it is said to be abundant at Basse-Terre.

Père Duss describes the *trunk* of *O. oleracea* as 30-36 m. high, rarely more, and measuring about 2 m. in circumference at its base, but it soon grows more slender and remains cylindrical throughout. The *leaflets* are equidistant, all on one plane, 3-3.5 cm. apart in the intermediate portion of the rachis; are of a rather herbaceous texture, lanceolate-ensiform, very long acuminate, shortly bifid at the apex, with the point in prolongation of the upper margin subulate and longer than the other; the intermediate leaflets are 70-75 cm. long and 5.5-5.8 cm. broad; those near the base are narrower and slightly shorter, the uppermost are smaller and less acuminate.

The inner *spathe* is thickly coriaceous, glabrous, of a reddish color inside, brown externally, from 70 cm. to 1.24 m. in length in vigorous young specimens.

The *spadix* is much branched, its peduncular part is 15-18 cm. long. The primary branches are as much as 90-95 cm. in length, form several partial panicles and are divided into several secondary and tertiary branchlets; the ultimate flowering branchlets are flexuose, 15-20 cm. long, carry ternate flowers on their lower part, but higher up only germinate male flowers.

Oreodoxa princeps Becc. sp. n.

A tree about 18 meters high (Harris). *Leaves* apparently similar to those of *O. regia*. Rachis dotted by very minute rusty scales. *Leaflets* pointing different ways; the two seen by me, belonging to the intermediate portion of the leaf, are lanceolate-ensiform, gradually acuminate above, somewhat larger than the largest of *O. regia* seen by me, about 80 cm. long, 6.5 cm. broad about their middle; have the mid-costa covered with chaffy scales a long way up from the base, but naked above. *Spadix* ultra compound; flowering branchlets more slender than in *O. regia*, up to 40-45 cm. long, 1.5-2 mm. thick at the base, the lowest divided

into 2-3 secondary branches, very gradually narrowing above to a very fine and acuminate point, slightly sinuous between the flowers; they carry glomerules of three flowers (one female between two males) on the lower two-thirds, and only germinate male flowers on the remainder; when bearing the fruits they are glabrous, but they appear to have been covered by the same kind of trichomes as in *O. oleracea* and *regia*, though of a somewhat different form (they are almost sessile and formed by a glomerule of very inflated and suddenly acuminate radiating cells). *Male flowers* considerably smaller than in *O. regia* and very irregular, when full grown in bud 3 mm. long, ovoid; sepals deltoid, hyaline; petals five

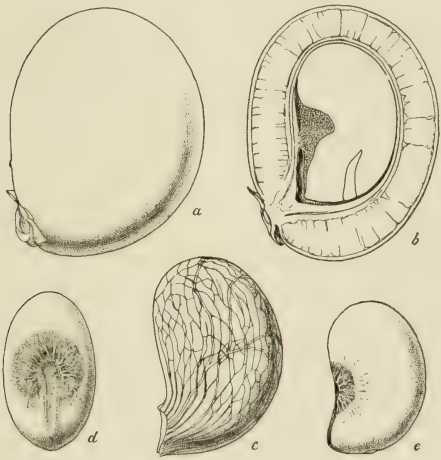


Figure 115. Oreodoxa princeps. a, fruit, side view; b, longitudinal section of the same fruit; c, the kernel of the above fruit; d, seed as seen from the raphal side; e, seed, side view.

times as long as the calyx, membranous, ovate, rather acute, concave. Stamens six, filaments terete, subulate, slightly longer than the petals during the anthesis; anthers broadly ovate, 1.5-2 mm. long, rounded at the apex, having the cells separated at the base nearly to the middle; the connective is broad and of a dark color. *Fruiting perianth* flattened, 5 mm. broad between the points of the petals; sepals hyaline, very narrow, form a very narrow ring round the scar at the base of the fruit; petals deltoid, bluntish. *Fruit* globose-obovoid and slightly asymmetrical or gibbous, 17 mm. long, 13 mm. broad, with the remains of the stigmas

placed a little above the base, very small and not prominent. Pericarp on the whole about 3 mm. thick and almost inflate, having the mesocarp almost empty in the dry state, and apparently very juicy when fresh; epicarp thinly pellicular, brittle; endocarp very thinly woody, it forms a shell to the seed 13-14 mm. in length and 8 mm. in breadth, rounded above, narrowing towards the base, which is rather acute and slightly bent; its outer surface is marked by a rather close net of fine fibers. *Seed* 10-11 mm. long, 6 mm. broad, entirely free from the inner wall of the endocarp, elliptical in outline on the front view, and subreniform when seen laterally, being slightly excavate on the side of the hilum and convex on the other side; it is rounded above, and rather acute at the base, has a dull brown surface, the vascular area of the raphe is suborbicular, and the hilum is in the middle of it; the intrusion of the raphe is broadly conical; the embryo is at the base, but a little apart from the point of the seed. (Figure 115).

The specimens upon which I have based the species were sent to me by Prof. Urban of the Berlin Botanical Museum and were collected by Mr. Wm. Harris (n. 9843) in Jamaica, in the Morass at Middle Quarters, 23 IX 1907.

Probably the plant has the appearance of *O. regia,* but it is not known if the trunk is cylindrical or has a tendency to take a fusiform shape. It differs from *O. regia* by its broader leaflets, by the spadices being more loosely branched and with longer and more slender branchlets, which bear female flowers accompanied by two males only in the lower two-thirds of the half part; but it differs especially by its small male flowers, and by its larger fruit, having a watery mesocarp (reduced almost to nothing in the dry fruit), and finally by its subreniform seed rounded above and subacute at the base.

PSEUDOPHOENIX H. Wendl.

H. Wendl. in Bot. Gaz. XI (1886) et in Gardn. Chr. IV (Ser. 3) Oct. 1888 p. 408 f. 56. *Sargentia* Wendl. (nomen) ex Nich. et Mott. Dict. Hort. et ex Sprenger in Bull. Soc. tosc. Ort 1889 p. 341. *Chamaephoenix* A. H. C. in Florida Farmer and Fruit Grower, Jacksonville, Febr. 22, 1887 (with a fig.). *Cyclospathe* O. F. Cook in Mem. Torrey Bot. Club, XII (1902) p. 25.

Sterile specimens of a *Pseudophoenix* distributed from the New York Botanical Garden, under the name of *Pseudophoenix sargentii,* were collected by Mr. J. A. Shafer (n. 6801) in March, 1909, at Cayo Guajaba, Camaguey on the north coast of Cuba. I have seen of these only some fragments of leaves, from which alone it is difficult to decide if they really belong to *Pseudophoenix sargentii,* or to an allied species. I make this observation because a species of *Pseudophoenix* different from that of Florida, was really in past times found in Haiti; this being the *Palma dactylifera et vinifera* of Plumier, which palm has not been as yet found again by modern botanists, but which may very possibly be the same plant as that collected by Shafer at Cayo Guajaba.

Pseudophoenix vinifera Becc. **Euterpe ? vinifera** Mart. Hist. Nat. Palm. v. III, p. LXXXV, t. morf. Z, II, fig. XVIII-XIX. **Cocos ? vinifera** Mart. l. c. v. III, 324. **Gaussia vinifera** Wendl. in Kerch. Palm. p. 245. **Palma dactylifera et vinifera** Plum. Gen. Amer. 3 Icon. t. 29, 30. ms.

I have seen in the Herbarium at Berlin a copy of the unpublished plates of Plumier's *Palma dactylifera et vinifera*, upon which Martius based his *Euterpe ? vinifera*, a palm, which up to the present day had remained an enigma. The accurate study hereafter reproduced, which I have made of *Pseudophoenix sargentii* has, however, enabled me to recognize in Plumier's palm a typical species of *Pseudophoenix*, which is quite distinct, however, from *P. sargentii*.

From the picture, the trunk of *Pseudophoenix vinifera* appears considerably more ventricose than that of *P. sargentii;* the spadix is more diffuse, and its branchlets more elongate, while the fruits, although distinctly pedicellate, are all represented as monospermous, but in them the traces of the other two sterile or empty locules are always well reproduced; in the analyses the perianth with six stamens is well shown, and in the seed, apparently somewhat enlarged, the few characteristic branches of the raphe are very apparent. If to these characters we add those of the spadices interfrondales, of the pinnate leaves with fascicled leaflets, and the relatively long leaf sheaths, the generic position of this palm appears to be positively certain.

Evidently this palm was once common in Haiti, where it was known under the native name of "Cacheo," but now it must have become very scarce or perhaps it has been destroyed, in consequence of the custom of the natives of felling the trees to extract the saccharine juice contained in the inflated part of its trunk, from which a kind of palm wine was obtained by fermentation.

Pseudophoenix sargentii H. Wendl. II cc.; Rev. Hort. 1887 p. 34, et 1888 p. 482 et 574, f. 140, 141; Bull. Soc. Tosc. Ort. 1887, p. 64; Garden and Forest, 1888, p. 352; Sargent, Silva N. A. v. X t. DV. **Chamaephoenix sargentii** A. H. C. l. c. **Sargentia aricocca** Wendl. l. c. et in Bull. Soc. Tosc. Ort. 1889, p. 341. **Cyclospathe northropi** O. F. Cook, l. c.

This palm, which was discovered by Prof. Sargent in Florida near the eastern end of Elliot's Key, is described as a tree with the general habit and appearance of *Oreodoxa*, 6-7 m. in height, with a trunk 25-30 cm. in diameter. From the figure in Gardener's Chronicle reproduced from a photograph taken in its native district in Florida, the *trunk* appears only very slightly fusiform. The leaves are said to be 1.20-1.50 m. long. An entire *leaf* detached from a plant cultivated at Miami, forwarded to me by Mr. A. T. Hudson, is 1 m. long in the pinniferous part; the *petiole* is very deeply channelled above and rounded beneath; the *leaflets* are numerous on each side, very approximate in the lower part of the rachis and distinctly approximate in groups of 2-3 on each side in the remainder, with vacant spaces 2-4 cm. long; the leaflets are firm in texture or thinly coriaceous, green above, glaucous beneath, linear-ensiform, strongly reduplicate at the base, gradually acuminate above; the largest leaflets, those of the middle, are 45 cm. long, 20-25 mm. broad; those near the base shorter; the mid-costa is very slender, not stronger than the secondary nerves, these are in number of 2-3 on each side of it; transverse veinlets obsolete.

The *spadix* is interfoliaceous, and it is described as about 1 m. in length, diffuse and much branched; the secondary (or tertiary?) branches are short,

and usually triparted; the flowering branchlets are glabrous, short, 2-4 cm. in length, and carry 8-14 flowers alternately and not very regularly inserted round the axis spreading and borne on a conspicuous pedicel 2.5-3 mm. long; the axes of the branchlets and the pedicels are terete and glabrous; the bracteoles at the base of the pedicels are inconspicuous. The *male flowers** in bud are broadly ovoid, with a perfectly round top, and slightly narrow towards the base; they are 5 mm. long and 4 mm. broad; the calyx is shallowly cupular, deeply parted into three deltoid acute lobes. Petals several times longer than the calyx, thickish, fleshy, ovate, concave, valvate. Stamens six; filaments terete, thickish, filiform, free from the base; anthers relatively very large, as long as the petals elongate-rectangular; their cells parallel, introrse, deeply separated at the base; rudimentary ovary conspicuous, elongate-conical, with three subulate stigmas, on the whole these are a little shorter than the anthers. In each branchlet the male flowers are far more numerous than the female. I have found only one female flower on a branchlet, while several other branchlets had only male flowers. The *female flowers* differ from the male resting on the same branchlet, in having the corolla apparently not fully developed, and by being only twice as long as the calyx, its divisions are deltoid, not connivent, but spreading with the stamens protruding beyond the corolla, and about twice as long as that; otherwise the stamens are identical with those of the male flowers; apparently they are perfectly developed, and we may suppose, fertile. The ovary is conical, and has three subulate stigmas, it is very similar to the ovary of the male flowers, only it is larger with a broader base, three-locular, and with a very minute ovule in each cell, situated in the lowest part of the ovary.

Fruit usually 2-3 lobed, bi- or tricoccous, similar to a fruit on an Euphorbiaceous plant, about 18 mm. broad (when dry), or it is monococcous and globose (and then 9-10 mm. in diam.) when two of the carpels remain sterile; the fruit is borne by a pedicel about 3 mm. long, and is suffulted by the deflexed petals, upon which at the base still remains visible the hardened filaments of the stamens. In the regularly developed three-lobed fruits, the remains of the stigmas are apical and central, but when only one or two or the carpels develop, they may be more or less shifted towards the base. The pericarp in the fresh fruit is fleshy, bright orange or red; when dry it is wrinkled, the epicarp being thin, pellicular, and adherent to the mesocarp; this is apparently mucilaginous, and devoid of fibrous strands; endocarp thinly woody, hard, and brittle, one-fourth of a millim. thick; it forms a globose kernel, 8.5-11 mm. in diameter with dull blackish even surface marked only by a slightly raised straight crest on the axial side. *Seed* free from the wall of the endocarp, globular, 7-8.5 mm. in diameter, at times slightly longer than broad, attached laterally on the axial side; it has a dull even surface, and is marked on each side by only two rather conspicuous arched branchings of the raphe. Albumen homogeneous. Embryo basilar on the axial side (Figure 116).

*I have studied the flowers preserved in formol, kindly forwarded to me by Mr. Ernest A. Bessey from Miami.

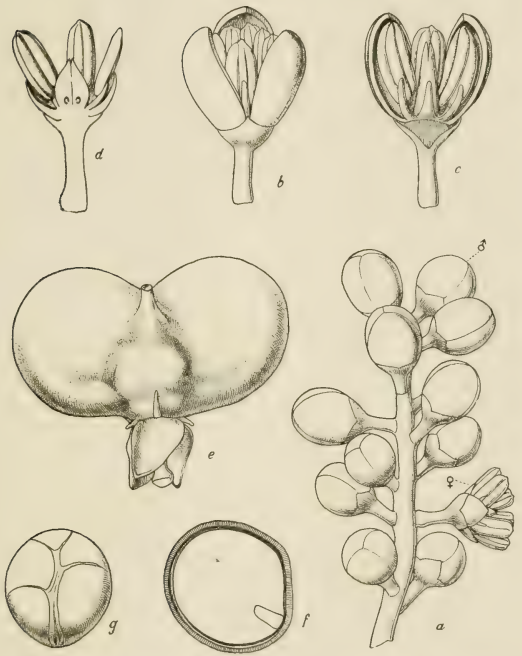


Figure 116. Pseudophoenix sargentii. a, branchlet with several male flowers in bud, and a female flower; b, male flower just before anthesis; c, male flowers from which a petal has been detached to show the interior; d, longitudinal section of a female flower; e, dry fruit containing two seeds; f, longitudinal section of a kernel and of its seed; g, seed seen from the raphal seed.

GAUSSIA H. Wendl.

H. Wendl., in Gottinger Nachrichten, 1856, p. 327; Benth. et Hook. Gen. pl. III, p. 912. *Aeria* O. F. Cook in Bull. Torrey bot. Club, 1901, p. 547.

Gaussia princeps* H. Wendl. l. c.; Griseb. Cat. pl. Cub. p. 221 (Wr. 3224); Sauvalle, Fl. Cub. n. 2383; G. Maza, Nociones etc. (1893) p. 50; **G. splendens** Becc. in Ann. Roy. Bot. Gard. Calcutta, v. XII, I, p. 9.

Gaussia princeps is not apparently a tall plant; the stem is rather stout, more or less inclining or bent at its base, and then ascendent and columnar; it has a smooth surface marked by very approximate ring-like scars, almost obsolete in the basal, but sufficiently distinct in the upper part of the trunk. The base of the trunk is raised from the ground by a very remarkable dense mass of roots, thickish, cylindrical, frequently dichotomically divided, covered by very small prickly warts, and, on the whole, similar to the ærial roots of a *Pandanus*. Here it is quite plain that the last formed roots are the more external, they are placed above all the others, and have of course made their way through the outer bark-like cylinder, appearing higher up on the stem, as this becomes older. This facility of producing epigeous roots in these palms is no doubt due to the great amount of aqueous vapour resting on the summit of the highest mountains, whereon they, too, find their proper home.

The *leaves* are also very remarkable; they are regularly pinnate, and have numerous very approximate leaflets, which are spreading almost horizontal; and are not arranged exactly on one plane, but point in different directions somewhat, and are furnished at their bases with a very conspicuous cushion-like swelling or callus. In the dry specimens this callus is much reduced and shrivelled, but in the fresh state it is certainly much swollen, and is probably fleshy. Several palms have leaflets with an axillary callus, but in none have I seen one so large as in *Gaussia*.

The *leaflets* are papery, ensiform, quite straight, open flat (not folded lengthwise), attached to the rachis by a broad base, where they are very suddenly contracted, and have the margins very briefly reduplicate, otherwise they have parallel margins a long way up, are gradually but excentrically acuminate above and, at times, are slightly indented a little below the apex; both surfaces are almost equally green, and very finely and sharply striately veined by secondary and tertiary nerves; the secondary nerves (5-6 on each side of the mid-costa) being only slightly stronger than several others; the mid-costa is rather strong, prominent and quite smooth on the lower surface, but is superficial and narrow in the upper, and towards the apex broadens and flattens considerably in a peculiar way; the margins are slightly and narrowly thickened and polished; there are no transverse veinlets visible; the intermediate leaflets are 50-55 cm. long and 2.5 cm. broad; the upper leaflets are shorter and narrower, more suddenly acuminate, briefly and often also obsoletely bidentate. The petiole is elongate

*While he lived in Cuba, Prof. Baker made an extensive introduction of this fine palm to horticulture, through Dr. Franceschi and others.

and gradually broadens at its base into a short, very broad leaf-sheath, which in the old and functionless leaves splits into two parts at the back. These leaves do not apparently remain long hanging down below the crown.

The *spadix* is apparently rather large and diffuse and is twice branched; glabrous throughout and quite destitute of bracts at every branching. The branch I have seen is 50 cm. long, it is divided into several alternate, spreading, filiform, gradually subulate, very elongate, flower-bearing branchlets, and has the lower portion of its axial part strongly flattened and 4-5 mm. broad; the lower branchlets are 20-25 mm. long and 1.5-2 mm. thick at their bases, subterete, but considerably wrinkled in the dry state; the upper gradually becoming shorter. The spadix has a long peduncular part, about 60 cm. in one specimen, sheathed rather tightly in a very thin, finely-striate marcescent spathe, which is split open laterally above and terminates in a hair-like acuminate point.

The *flowers* are horizontal, quite sessile, clustered in small linear series of 3-5 longitudinally around the branchlets; the flowers in each group are placed immediately one above the other and in contact; the lowest in each group is usually female and the others are males; the elongate superficial scrobicules have no bracts and are edged by a slightly elevated rim.

The *male flowers* in full grown buds are broadly or very briefly obovoid, 3 mm. long, 2 mm. broad, with a rounded top and flattish base; the calyx is cupular, truncate at the mouth; the sepals are imbricate, quite free, thick and fleshy especially at the base, with blackish margins. The corolla is nearly four times as long as the calyx; petals concave, spreading during the anthesis, ovoid, obtuse, strongly striately veined, rather thick and fleshy; stamens six, slightly shorter than the petals; filaments free from the base; the anthers inserted about the middle of the dorsum, are large, ovoid, and subcordate at the base; rudimentary ovary conspicuous, elongate-conical, slightly shorter than the stamens, terminated by three short blunt stigmas.

Female flowers at the time that the buds of the males are fully developed, are smaller than these, conical and more acute than the males; when fully developed 3.5 mm. long; sepals small, fleshy, orbicular-reniform; petals much larger than the sepals, deltoid, bluntish, thickly fleshy; ovary broadly pyramidate-trigonous; stigmas obtuse; ovules three, very minute, attached to the base at the inner side of the cells. Staminodes very minute, short and thickish. The fruits are obovoid, with a rounded top and taper somewhat towards a slightly asymmetrical or bent base, where a little above the torus remain the relics of the small conical stigmas. They (when dry) are 10-11 mm. long, by 7 mm. broad, and have the pericarp contracted and wrinkled; in the fresh state they certainly are somewhat fleshy; the pericarp has a thin resistant epicarp, a slightly pulpy mesocarp quite devoid of fibers, and a very thin membranous hyalin endocarp. The *seed* is obovoid, rounded above, and narrows to an acute, almost pungent, slightly bent base; its surface is dull and marked by few loosely anastamosing vascular branches of the raphe; the embryo remains on the more convex side of the seed, a little below the middle; the albumen is homogeneous, and of a not very hard texture.

The *perianth* apparently is not accrescent after flowering, is spread under the fruit, and is about 5 mm. in diameter; the sepals are subreniform; the petals are considerably larger and longer than the sepals, deltoid, bluntish, thickish, and obsoletely striately veined externally; the remains of six filaments are still visible in the shape of six very small conical bodies. (Figures 117, 118).

I have seen of *Gaussia princeps* Wright's typical specimens with fruit only (n. 3224 Herb. Berol.) upon which the species was founded, and I had the opportunity of examining very good specimens with flowers, collected by Britton, Earle and Gager (n. 6792 in Berl. Herb.) at San Diego de los Baños, Province Pinar del Rio; others with fruits were gathered, I think, in the same locality by van Hermann (n. 3463 in Herb. Bece. and Berol.)

In my monograph of the Genus *Daemonorops* (Vol. XII of the "Annals of the Royal Botanic Garden of Calcutta," p. 9) I have published some observations on the peculiar cushions or callosities, so frequently found in the axillas of the leaflets in palm leaves, and have also mentioned those of a *Gaussia splendens*, which name, however, is only an oversight for *Gaussia princeps*.

Figure 117. Gaussia princeps. a, portion of a flowering branchlet; b, male flower in bud; c, male flower during anthesis; d, longitudinal section of a young female flower; e, longitudinal section of a young fruit.

Gaussia attenuata Becc. **Aeria attenuata** O. F. Cook in Torrey bot. Club, 1901, p. 548, t. 47.

Dr. U. Dammer and Prof. I. Urban have already expressed the opinion (Urban, Symb. Antill. IV, 129) that the Genus *Aeria* might, possibly, be reduced to *Gaussia*. I am now able from inspection of the flowers and fruit of the type of *Aeria* (Cook No. 1040) to confirm this opinion, and I have, moreover, found *A. attenuata* to be rather closely related to *Gaussia princeps*, from which it differs in its more elongate stem, and in the somewhat larger fruit and seed. The flowers are very similar in arrangement and form in both plants; those of *G. attenuata*

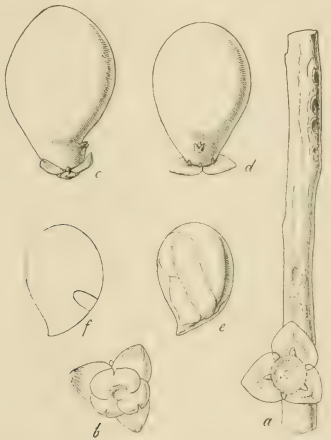


Figure 118. Gaussia princeps. a, branchlet with a fruiting perianth; c, fruit, side view; d, fruit, front view; e, seed, side view; f, seed cut longitudinally through the embryo.

are, however, more globose than those of *G. princeps*, have the petals less distinctly striately veined, and are also marked by fewer veins than those of the latter.

According to Cook, *G. attenuata* has the leaflets without basal cushions, the fresh fruit of a deep orange color, 16 mm. long by 12 mm., and the seed flattened-oval. The only dry fruit I have seen is obovoid, 15 mm. long, 11 mm. broad; the seed is 11 mm. long, 7.5 mm. broad, regular obovoid, not at all flattened, it has a round top and narrows at the base to a symmetrical, bluntish (not bent) point;

the albumen is homogeneous, entirely solid, without central cavity. The embryo is lateral, a little below the middle.

Other mentioned species of *Gaussia* are:

G. ghiesbreghtii H. Wendl. in Kerch. Palms 245. *Chamaedorea ghiesbreghtii* Hort. and *Oreodoxa ventricosa* Hort. It is a very problematic palm.

Gaussia portoricensis Wendl. l. c. (nomen): is supposed to correspond to *Gaussia* (*Aeria* O. F. Cook) *attenuata* Becc.

Gaussia vinifera Wendl. l. c., is *Pseudophoenix vinifera* Becc.

The Cherimoya in California

With Notes on Some Other Anonaceous Fruits

F. W. POPENOE
WEST INDIA GARDENS, ALTADENA, CALIFORNIA

The Cherimoya has not yet assumed an important place among the cultivated fruits of California. This cannot be attributed to any fault in the fruit itself, since in its better varieties it is one of the finest known to horticulture. Neither can it be said that the climate and soil of Southern California are not adapted to it, as forty years of cultivation have shown the tree to be hardy here, and fruits of fine quality have been produced.

The real cause of this regrettable state of affairs is not hard to determine. It does not lie deep below the surface, but is plainly apparent upon investigation. The fact is, we have been perpetuating only inferior seedlings. Thus the fault lies with our horticulturists and not with California or the fruit.

Had the precaution been taken to propagate from the best of our local seedlings, to say nothing of introducing better varieties, we would have many good Cherimoya orchards in our state at this time. Had the most desirable varieties been searched out from the countries to the south of us, or from other parts of the world wherein our own climatic conditions are paralleled, it is not assuming too much to say that the Cherimoya would now be regarded as one of the important fruits of this region. In other parts of the world where it has reached a high state of perfection, as in Madeira and the Canary Islands, it has become an important product, and vineyards are being replaced by Cherimoya orchards.

Where grown to perfection the Cherimoya is classed as one of the three finest fruits of the world, the other two being the Pineapple and the Mangosteen, —a royal trio indeed! A fully ripe Cherimoya is so delicious that it is safe to say not one out of a hundred on first tasting it would be other than delighted; in fact, this was exactly the case at a recent flower show at Pasadena, where a number of fine Cherimoyas from Mexico were exhibited and visitors permitted to sample them. In flavor and character the flesh may be likened to a delicious sherbert or ice cream. When prepared as it is in the tropics—thoroughly chilled on ice—there are few desserts that equal it.

On the great central plateau of Mexico, under climatic conditions almost identical with those of Southern California, it is not uncommon to find trees bearing two or three hundred of these delicious fruits. Why, then, should not the attention of our horticulturists be more earnestly addressed to the reproduction of such conditions here?

That so little is known in California of this superb fruit—its culture, its value, and its possibilities for this state—has seemed to warrant the preparation of this preliminary paper on the subject.

History and Cultivation in California

As far as is definitely known, the Cherimoya was first introduced to California in 1871, by the late Judge R. B. Ord of Santa Barbara. Dr. Franceschi, who has investigated the subject thoroughly, is unable to learn of any earlier introduction than this, and although it would seem natural that the early Mexican settlers should have brought this fruit with them, such does not seem to have been the case.

From the trees brought from Mexico by Judge Ord, many seedlings have been raised and planted in Santa Barbara and vicinity. Further south, some of

Figure 119. A fifteen-year-old seedling Cherimoya in the A. Z. Taft grove at Hollywood, California, showing what the tree will do in California under proper cultivation.

the first trees planted were on the Jacob Miller place in the Cahuenga valley, just outside of Hollywood, where the Cherimoya grows to perfection and is found in larger numbers than in any other locality in the state. The early impetus here given it has resulted in it being quite common in the gardens of Hollywood, and along the slopes of the valley to the west. Certainly it could not be more at home anywhere than it is here, the tree reaching a large size, and the fruit ripening perfectly. While it fruits well at Santa Barbara and in many other localities, there seems to be something peculiarly suited to it in the conditions of soil and climate of the foothill regions.

The superior hardiness of the Cherimoya has made it one of the most widely planted of the lesser-known subtropical fruits. The number of mature specimens is not more than a few hundred, but their wide distribution and success go to prove the adaptability of the tree to an extensive area in this state. Of these seedlings scattered throughout the gardens of Southern California, practically all have been successful so far as growth is concerned, but a large percentage are scantily productive. A study of the habits of the tree shows this to be nothing unusual and not due to anything unfavorable in our climate or soil. The Cherimoya is never enormously productive. But there are occasional seedlings much more prolific than the average, and this is the case in California as well as other countries.

Figure 120. A seven-year-old budded tree of the Golden Russet Cherimoya grown by C. P. Taft at Orange, California.

Cultivation on a commercial scale has been undertaken in but few instances, and with unsatisfactory results in practically all of them, the trees failing to produce sufficiently to make their culture profitable. For this difficulty a single, and exceedingly simple, remedy suggests itself—asexual propagation—making possible the perpetuation of productive and otherwise desirable seedlings, true to type. This is already practiced in other countries, and here to a very limited extent.

The largest grove of Cherimoyas in California is that owned by A. Z. Taft of Hollywood, consisting of some eighty fifteen-year-old seedlings. No finer specimens could be desired than some of these, but the majority of them are deplorably unproductive,—if the five best trees were taken out, a bushel of fruit

could not be gathered from the lot. One tree alone, more prolific than the others, produces about one-fourth as many fruits as the remaining trees taken together. It is easily seen that such a grove does not pay for the care bestowed upon it, but if worked over to a prolific variety it could be transformed into a very profitable holding.

It has been questioned by some whether the climate of California will produce a Cherimoya of the best quality. This query arises from the fact that many of the fruits produced here are of poor flavor. The explanation is that seeds from inferior fruits have been planted, and a lot of degenerate seedlings produced. Experience leaves no doubt on this point, since some of the fruits grown here are all that could be desired in flavor and quality.

Botanical Description

The genus *Anona* comprises about sixty species, indigenous to tropical America and Africa. Several members of the genus are cultivated for their fruit, notably the Sugar Apple (*A. squamosa*), the Sour Sop (*A. muricata*), and the Custard Apple (*A. reticulata*).

The Cherimoya, *Anona Cherimolia* Miller, while not so widely cultivated as the above mentioned species, is nevertheless one of the most noteworthy and valuable. It is a small tree, fifteen to twenty-five feet in height, much branched and spreading, with grayish bark, the branches rounded and the young growth scurfy-pubescent.

Leaves alternate, ovate, acuminate, sometimes obtuse, bright green and sparsely hairy above, grayish-pubescent beneath; petiole five-eighths inch long. Flowers solitary, axillary, small and very fragrant, peduncle short. Calyx composed of three small, valvate sepals. Petals six, arranged in two series; the three exterior valvate, fleshy, greenish outside and whitish within, oblong-linear, keeled on the inner side; the three interior minute, sometimes wanting. Stamens indefinite, inserted on the hemispherical receptacle. Carpels, also indefinite, distinct but cohering loosely among themselves and containing a single ovule; style oblong. Fruit compound, made up of the individual fruits (berries) derived from the separate carpels, sunk in and united with the fleshy receptacle, sometimes eight inches in length, conical, ovate, or globose, frequently irregular, greenish, brownish or yellowish in color; the surface sometimes smooth, but frequently covered or partially covered with more or less prominent protuberances, one arising from each pentagonal carpellary area. Seeds three-eighths to three-fourths inch in length, oblong or oval, more or less compressed, brown, containing the characteristic ruminated endosperm.

The Natural Order *Anonaceae*, to which the Cherimoya belongs, includes 96 genera and 620 species, according to Dr. Willis, the majority being found within the tropics, both in the old world and the new world. The order includes numerous fruit producing shrubs and trees, of which may be mentioned in particular, besides the genus *Anona*, *Rollinia orthopetala* and *R. emarginata*, natives of South America and among the finest of the anonaceous fruits; *Asimina triloba*, the "Papaw" of eastern and central United States; and several species of

Uvaria, natives of Mexico and southern Asia. The Ylang-Ylang (*Cananga odorata*), a native of southern Asia, from which a perfume is distilled, is also a member of the order.

Origin

DeCandolle, in his monumental work "Origin of Cultivated Plants," discusses this subject at length, and states in conclusion, "I consider it most probable that the species is indigenous in Ecuador, and perhaps in the neighboring part of Peru." This statement was based mainly upon the opinions of early botanists who had collected in South America. That he was not certain in his conclusion is plainly expressed in the conclusion itself, but until recently his verdict has been generally accepted as correct. Some few, however, have held to the belief that the species is indigenous in Mexico and Central America as well as Peru and

Figure 121. A prolific Cherimoya tree at the C. W. Mitchell residence in Sierra Madre, California.

Ecuador, and recent researches by Prof. Gabriel Alcocer of the Mexican National Museum seem to prove that it is exclusively Central American, having been introduced to South America from Guatemala. In a Spanish work entitled "Historia del Nuevo Mundo," it appears that the author, P. Bernabe Cobo, while traveling from Peru to Mexico in the year 1629, found the Cherimoya in Guatemala City, and was so pleased with it that he despatched some seeds to his friends in Peru, where it was unknown at that time. Upon returning there thirteen years later,

he found that a number of trees had been raised and were in bearing, but the fruit was still scarce and sold in the markets from eight to twelve reales each. It was more than one hundred years later that the first Cherimoya seeds found their way to Europe, and having come from Peru it was naturally supposed that the tree was a native of that country. Later, when European botanists found the tree in an apparently wild state in the mountains of Peru and Ecuador, this belief was more firmly established, but it is plainly apparent that the tree might have become naturalized in the two hundred years that had elapsed since its introduction, even to such an extent as to lead to the belief that it was native. Prof. Alcocer points out that the work, "Historia del Nuevo Mundo," was unknown to DeCandolle, and he also presents much other evidence in favor of a Central American origin, with the result that little room is left for doubt.

Figure 122. Fruits of Cherimoya on a young tree at Hollywood, California.

Common Names

In Mexico the common name of this fruit is spelled "Chirimoya." Evidently a different spelling is used in Peru, giving rise to the specific name *Cherimolia* and the English adaptations "Cherimoya" and "Cherimoyer," the latter most commonly used in the British colonies. Though the fruit came to California from Mexico, the spelling "Cherimoya" has been generally adopted by horticulturists in this state and will, in all probability, eventually supersede all others.

Some authorities have termed all members of the genus *Anona* "Custard Apple" individually and collectively, it is extremely undesirable that the Cherimoya be known under this name, which properly belongs to the West Indian *Anona reticulata*, a fruit similar to the Cherimoya in many characteristics.

but greatly inferior in quality. The listing of the Cherimoya under the name "Custard Apple" has already led to much confusion among nurserymen and horticulturists in this state, some, knowing that this name was applied to *A. reticulata* going so far as to list this species and *A. Cherimolia* as synonymous. Furthermore, the Cherimoya suffers a certain loss of prestige through this confusion—sufficient in itself to merit careful discrimination on the part of all those describing or listing it.

Climatic Requirements

That the Cherimoya is not highly successful in strictly tropical countries is conclusively shown by the fact that even when it has been grown for some time in such regions and is comparatively well known, it is not held in high esteem. It is reported that it succeeds in some parts of Ceylon, and is popular with the

Figure 123. A Cherimoya tree in the A. Z. Taft grove at Hollywood, California, probably one of the finest specimens in the State.

natives. Obviously it is not at its best or it would call for a greater degree of enthusiasm. In Jamaica it is only a success in the coolest and dryest parts of the island. Writers in other parts of the West Indies, and in Reunion, have remarked that it is not as fine a fruit as some other members of the genus.

But a glance at its popularity in the Mexican highlands, Madeira, the Canary Islands, and Peru shows a contrary state of affairs. It has reached a degree of perfection never attained in tropical lowlands, and is esteemed as one of the finest of all fruits.

The great central plateau of Mexico may be taken as an example of climatic conditions best suited to this fruit, since it is there found in perfection, and has been cultivated from the remotest antiquity. Comparatively high temperatures accompanied by a very low degree of humidity are the rule during the dry season, the winters being cool and the annual precipitation not great—a climate very similar on the whole to that of Southern California. And indeed it is not necessary to search elsewhere to determine the requirements of this fruit, since forty years' successful cultivation in this state has proved them to be fulfilled here to a very satisfactory degree. Two factors which seem to be particularly important are freedom from excessive humidity or precipitation, and cool (but not frosty) weather at the time of ripening.

Figure 124. Trunk of Cherimoya tree shown in Figure 123, almost a foot and a half in diameter.

Prof. Foex, in "Algunas Anonaceas Frutales de Mexico" (Bulletin No. 9 of the Estacion Agricola Central, Oaxaca), says: "Of the Anonas grown in Mexico the Cherimoya is the most resistant to cold, and suffers most from excessive heat. * * * When grown in a region of moderate temperatures it is considered the best of all the Anonas; grown in a hot climate it is not superior to *Anona squamosa*."

The hardiness of the tree has been so thoroughly tested in this state as to leave no room for dispute, and it can be relied upon to succeed in locations suited to citrus fruits, with the same amount of protection. The same provision must be made as with the citrus fruits, however, that some localities will produce finer fruit than others. And it must be recognized and remembered that varieties intro-

duced from other countries will not necessarily be successful here—if from climates widely different from our own—without undergoing a process of acclimatization.

Propagation

Although the majority of Cherimoyas in this state are seedlings, the tree can be readily budded. It is only through this or some other asexual means of propagation that desirable forms originated as chance seedlings can be perpetuated, and Cherimoya culture on a commercial scale made profitable.

Figure 125. Parent tree of the Mammillaris Cherimoya, at Altadena, California, on the property now owned by A. C. Calkins.

Seeds are sometimes obtainable in the fall, but more frequently during early spring. If a glass-house or hot-bed is available they may be planted at any time, but if no artificial heat can be supplied it is best to defer planting until the advent of warm weather, usually in April or early in May. For germinating the seeds an excellent medium is a mixture of two-thirds silver sand and one-third *old* redwood sawdust; lacking this, any light, well-drained soil can be used with

Figure 126. Showing one of the very best types of Cherimoya, this being five inches in length and weighing a pound and a half.

good results. The seeds should be covered to a depth of half an inch, and if conditions are favorable they will germinate within four or five weeks. The young plants should be potted off when they have attained a height of three or four inches, using pots of a diameter not less than two and a half inches. The plants are not particular as to soil, it only being necessary that it is light and porous.

Budding is best done in early spring, shortly after the sap has begun to flow. In some seasons this will be as early as the first of March, but more frequently late in March or early in April. The trees should be watched and the work begun as soon as it is found the bark will slip readily.

Figure 127. A plate of Cherimoyas as grown at an altitude of 7000 feet in the highlands of Mexico.

The most advantageous method of budding the Cherimoya is that known as shield budding, the operation being practically the same as with the citrus fruits. Mr. C. P. Taft of Orange obtained excellent results from his first attempt, but later found that even though the work was done under favorable conditions the buds would sometimes fail to grow. The stocks used by Mr. Taft have been seedling Cherimoyas; in Florida Mr. Wester has budded on *Anona glabra, A. squamosa,* and *A. reticulata,* finding *A. glabra* the most vigorous and satisfactory. It is not certain that this species will be equally satisfactory in California, however.

The stocks should be from three-eighths to one-half inch in diameter—seedlings of this size being usually from a year to a year and a half old. Wood from which the leaves have dropped and of about a year's growth is the most desirable for budwood, and Mr. Wester advises cutting the buds not less than an inch and

a quarter in length. If cut smaller than this, on account of the rapid callousing and thick bark of the Anonas, the buds have difficulty in starting and are choked out. Insert the buds exactly as in budding citrus fruits, and tie with waxed tape. At the end of three or four weeks they should be unwrapped, and if alive, the tree should be lopped back and the bud rewrapped loosely, leaving the "eye" exposed so that it may start into growth. The buds of the Cherimoya are sunk into the bark tissues, and there is not the danger of their dropping and leaving a "blind" bud that there is with the avocado.

In Madeira and the Canary Islands grafting is extensively practiced. Dr. Trabut, in the Bulletin Agricole de l'Algerie et de la Tunisie, advises grafting as being much more successful than budding. Two-year-old seedlings are used, the operation itself being a simple cleft-graft.

Figure 128. Showing a collection of the different types of seedling Cherimoyas occurring in Southern California—these from one grove at Hollywood.

Culture

Experience in California has shown that the Cherimoya thrives under the same treatment accorded the Citrus fruits. The seedlings grow to much larger size than any of the Citrus trees, however, and should be planted at least twenty-five feet apart. Budded trees will probably require less room, as budding dwarfs the tree to a certain extent.

The tree has proved to be about as hardy as the orange—though this must be largely a matter of variety—and is semi-deciduous in nature, the extent being dependant upon the severity of the climate.

Whether seedling or budded, the tree ordinarily comes into bearing about the fourth year. The fact that large trees are quite frequently unproductive, though blooming profusely, has led to a series of investigations by P. J. Wester of the U. S. Dept. of Agriculture, which throw considerable light on the matter, although there is still much to be learned. Mr. Wester found that the flowers of the Cherimoya were unable to fertilize themselves because of the pistils maturing before the stamens, and consequently not receptive to the pollen when

it was liberated, thus necessitating the assistance of some outside agency for fertilization. The pollination of the mature pistils with pollen from another flower was attributed to insects. Mr. Wester believed the sterility of the Cherimoya in Florida to be due to a scarcity of flowers and an insufficient number of insects to assist in pollinating them. He further states that "the extraordinary productivity of a few individual trees suggests a change in regard to the pollination of the flowers of these trees, possibly due to synacmy and self-pollination."

In Madeira and the Canary Islands the cultivation of the Cherimoya is carried on systematically, the trees being pruned and manure regularly supplied.

Figure 129. Showing what the Cherimoya may be in Southern California. A fine specimen from Hollywood, weighing 18 ounces.

Diseases

In California no diseases affecting the Cherimoya have been observed; if they are present, they do not seriously interfere with growth, and have not been of sufficient importance to become evident. In other countries, however, the tree seems to be subject to certain fungus diseases, probably unknown here.

Jumelle (Les Cultures Coloniales, p. 176) remarks: "It is well to replace the trees when they commence to get old, as they are subject to the attacks of a blight."

In a paper read before the Cuban National Horticultural Society, and published in the Society's report for 1910, H. A. Van Hermann says: "The cultivation of Anonas for commercial purposes will need some careful attention. The fruit when young is affected by both fungi and insects, which disfigure it. Spraying may be necessary to grow perfect fruits in some localities."

Mr. R. H. Johnston of the hacienda "La Queseria" in the state of Jalisco, Mexico, reports that many of the trees, which are given practically no cultivation in that vicinity, are subject to a serious disease somewhat similar to the pear canker.

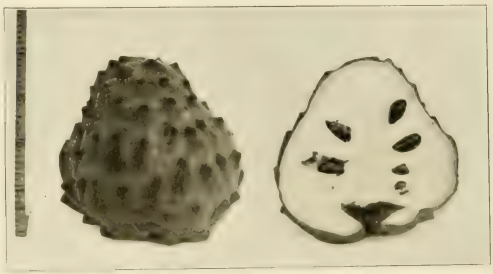


Figure 130. The Mammillaris Cherimoya as grown at Altadena, California.

Insect Pests

Even though in close proximity to infested citrus and other trees, none of the local Cherimoyas appear to be bothered by any insect pests. But it is evident that the species is not immune from the attacks of pernicious insects. The Bulletin Agricole de l'Algerie et de la Tunisie for March 15, 1908, contains an account of the Cherimoya in Algeria by Dr. L. Trabut, in which he states that old trees are nearly always infested with the "Cochenille blanche" (Mealy Bug) requiring stringent combative measures. Fumigation is advised, the work to be done during the winter months. In Southern California, the work of Essig and others has shown that the Mealy Bug can be most effectively handled by the use of carbolic emulsion.

Throughout the warmer parts of America there are small chalcid flies related to the wheat joint-worm and the grapeseed chalcid which infest the seeds of anonaceous fruits particularly those of *Anona squamosa*. These are so widely distributed that they will be practically certain to appear eventually in Southern

California. All seed from southern sources should be carefully examined on being received.

Season

In this state the main season for Cherimoyas is March and April, although in favorable weather a few fruits may mature in the fall. The entire crop does not ripen at one time, the fruits maturing individually and extending the season over six or eight weeks.

The fruit does not ripen on the tree, and must be picked when mature—to avoid its dropping to the ground and becoming bruised—and laid away for three or four days before it is in condition for eating. That it is difficult for some to judge when the fruit should be picked is evidenced by the fact that mature, and sometimes half-grown, fruits are often found in the markets. These immature fruits are easily distinguished by their becoming dark brown upon softening, accompanied by a hardness of the surface that is never present in the ripe fruit.

Figure 131. The Golden Russet Cherimoya as grown at Orange, California.

When fully ripe and ready to pick, the fruit assumes a yellowish tinge, more pronounced in some varieties than in others, and yields slightly to pressure of the thumb.

In certain states of Mexico Cherimoyas are obtainable throughout the year. The season has not been greatly extended by seedling variation in California, since fruit can not be obtained in quantity for more than three months. Doubtless by introducing varieties from other countries it would be possible to greatly prolong the period.

Unfavorable weather at the time of ripening has a pronounced effect on the flavor and size of the fruit, both suffering considerably in severe seasons.

Shipping

That the Cherimoya could be successfully shipped to any part of the country without difficulty is shown by the fact that numerous shipments to this state from southern Mexico have arrived in excellent condition, even though no care was

used in packing. After picking, the fruits do not soften up sufficiently to be easily bruised within three or four days, and this time can be greatly extended by refrigeration. With the selection of the toughest-skinned varieties for this purpose, there should be no difficulty in placing the Cherimoya on the markets of any part of the country.

A more complete treatment of this subject will be found in Prof. Foex' bulletin "Algunas Anonaceas Frutales de Mexico," already referred to.

Nature and Extent of Seedling Variation

Notwithstanding some statements to the effect that the Cherimoya comes true from seed, the variation exhibited by the seedlings in Southern California, many of which have sprung from a common parent, demonstrates conclusively that asexual propagation must be resorted to in order to perpetuate a variety absolutely true to type. Although the distinct departures from the parent type which are frequently shown by seedlings of some other cultivated fruits do not appear to exist in this species, in variation of seedlings, and particularly in variation of fruits on the same tree, it is peculiar and extraordinary.

As observed among the local trees, the most important characteristics in which variation is shown, and the extent of variation in each, are briefly as follows:

A. Variations Affecting the Tree.

1. *Productiveness.* A large percentage of seedlings are so unproductive as to be of no value. Many produce moderately, and an occasional tree is so exceptionally productive (comparatively speaking) as to make it of great value for propagation, provided it is otherwise desirable. These productive trees are quite frequently isolated specimens, showing that the difference is not due to cross fertilization, or an abundance of pollen supplied by other trees. Mr. Wester suggests that the flowers of these trees may be self-fertile, as opposed to the majority of Cherimoyas which are dependent on insects for pollination. Whether this be the case or not, it is certain that the bearing habits of a tree are perpetuated by asexual propagation, and thus all danger of trees turning out to be shy bearers can be eliminated.

It is quite possible that the productiveness of many of the local trees could be increased through better attention to culture, since many of them have been subjected to severe neglect.

2. *Foliage.* On one plantation in the Cahuenga valley there are a few trees whose leaves are uniformly two or three times the ordinary size, being eight to ten inches in length and five to six inches in breadth. It is not rare for seedlings to show this variation, and the fruits produced by such trees do not appear to differ from the ordinary in any respect.

B. Variations Affecting the Fruit.

1. *Surface.* In respect to surface, the local seedlings may be broadly divided into two classes; those with more or less prominent protuberances over the greater portion of the surface, and those without protuberances, in which the

surface is smooth and the carpellary areas are defined by raised lines, or in which the carpellary areas are individually concave. There are, of course, many forms intermediate between these two, and extreme forms of each. While both smooth and rough fruits are sometimes produced by the same tree, and some trees produce fruits which are covered with protuberances when young but become smooth at maturity, there are many which uniformly produce fruits of one type. Thus in the Mammillaris variety the mammiform protuberances are present on all specimens, and in the Golden Russet the protuberances near the base, which disappear towards the apex and are replaced by concavity of the carpellary areas, are characteristics which are almost always present.

2. *Size.* In this respect the Cherimoya is extraordinary, it being possible to find mature fruits all the way from an inch to six inches in diameter on many trees, whether seedling or budded. Ordinarily, only a small percentage of the fruits

Figure 132. On the left a view in the huerta of Herman Evers, at Mazatlan, Mexico, showing a young Cherimoya in bearing; on the right, a large tree near Colima, Mexico, photographed during the winter season and showing the deciduous nature of the tree in cold climates.

attain large size, although some trees are more uniform in this respect than others.

3. *Form.* The commonest form is conical or oblong-conical, but some varieties are normally cordate and there are many seedlings among whose fruits it would be difficult to determine a normal form. Rarely is there a tree whose fruits are all of uniform shape. Even among perfect specimens there is considerable variation, and many malformed fruits are produced, due, without doubt, to imperfect fertilization of the flowers.

4. *Color.* Although commonly a dull green, there is considerable variation in coloring, some varieties being light russet at maturity. Since any other color than green is only assumed in favorable weather, it is evident that coloring is largely a matter of weather conditions, becoming most pronounced in the hottest seasons.

5. *Seeds.* Among the seeds of different varieties there are no great differences. The average number of seeds, while greater in fruits of some varieties than others, is largely a matter of the individual specimen. Slight differences in the form of the seeds are frequently noticeable.

6. *Quality.* It is natural that some seedlings should produce fruits of inferior quality. Occasionally a very superior one is found.

Varieties

In general characteristics of fruit many of the local seedlings are practically identical; furthermore, as has already been noted, the variation existing among fruits on the same tree is great. This makes it impracticable to distinguish between any large number of varieties, and renders difficult the describing of a variety in such a way that every fruit produced will answer to the description, without entering at length into the range of variation exhibited within the variety.

When the most prolific and desirable of the local trees come to be propagated by budding or grafting, and are offered by the nurserymen, it will be essential that each one be given a name and that accurate descriptions and illustrations be placed on record for the guidance of prospective planters. As yet only two named varieties have been offered. Both these are desirable, but it is highly probable that much finer forms will be introduced within the next few years from other countries where this fruit has been given more attention that it has here. In Madeira, seedling selection has resulted in the production of varieties weighing as much as sixteen pounds, and with very few seeds. Choice forms, adapted to varied conditions of soil and climate and bearing at different seasons of the year, have been produced in several countries, and it will be much more expedient to direct our efforts toward obtaining as many of these as possible, rather than to the production of superior varieties through seedling selection,—necessarily a slow and laborious process at best.

Mammillaris

This variety originated as a seedling at Altadena, California, on the property now owned by A. C. Calkins. In flavor it is greatly superior to the majority of local seedlings, and its exceptionally tough skin renders it of value for shipping. Although not a fruit of large size, it must be ranked as one of the best which have originated locally.

Description—Form distinctly conical, more uniformly so than with most other varieties; size medium; weight up to one pound; length up to four and a half inches; width up to four inches; base flattened; cavity shallow, broad, flaring, regular; apex rather pointed; stem short and very stout; surface covered with more or less prominent conical protuberances, one arising from each carpellary area over the entire fruit; color dull green; skin thick and very tough; flesh clear white, soft, fine grained; seeds rather short and blunt, plump, not very numerous; flavor very aromatic and rich, strongly resembling the pineapple; quality excellent; season February March at Altadena, California.

Tree upright; growth close, moderately vigorous; productiveness very good; seems to be hardier than many other Cherimoyas. This is the first description of this variety.

Golden Russet

A variety of obscure origin, received in the form of two budded trees from London, England, by Mr. Burgess of Villa Park, California, some years ago. It was under this name when received. It has been propagated by C. P. Taft of Orange, who has a number of budded trees in bearing. A very good variety, but as produced at Orange it is inferior in flavor to *Mammillaris*.

Description—Form normally oblong-conical, but extremely variable; size medium large; weight up to a pound and a half; length up to seven inches; width up to five inches; base flattened; cavity deep, rather narrow, rounded, regular; apex rounded, broad; stem short and stout; surface near base giving rise to a rounded and not very prominent protuberance from each carpellary area, toward apex the protuberances disappear and the carpellary areas are concave; color light green, usually shaded with, or varying to, golden russet; skin rather thin, tender; flesh white, of good texture; seeds oblong, slightly compressed, not very numerous; flavor resembling the pineapple but not so rich as in *Mammillaris;* quality good; season February-April, occasional specimens ripening in the fall, at Orange, California.

Tree upright, broad topped; growth vigorous, rather open; productiveness fairly good.

OTHER SPECIES OF ANONA FRUITED IN CALIFORNIA

Anona macrocarpa

Considered by some authorities to be a horticultural form of *A. Cherimolia,* but believed by Dr. Franceschi, who introduced it to California, to be distinct.

The most marked characteristic of the species is the large size of the leaves, which causes Dr. Franceschi to note that it might better be called *macrophylla,* the fruits being proportionately not so large, although larger than the ordinary Cherimoya, and of excellent quality. The seeds are distinct from those of *A. Cherimolia.* It is believed to have originated in Orotava, Teneriffe, and has proved hardy at Santa Barbara.

Anona reniformis

Also introduced by Dr. Franceschi, who describes it as of dwarf habit and more spreading than the Cherimoya, with smaller and more coriaceous leaves. The flowers are very fragrant, and are produced in great profusion over a longer period than with other species. A sparse bearer, the fruits reniform, of small size, and indifferent quality. Not authentic, but for its distinctiveness in foliage, in fruit, and particularly in seeds, considered by Dr. Franceschi to rank as a distinct species.

Anona suavissima

Also considered a horticultural form of *A. Cherimolia* by some authorities. It was described about 1820 by Prof. Tenore, Director of the Botanic Garden at

Naples, Italy, from whence it was introduced to California by Dr. Franceschi. Similar to *A. Cherimolia* in most characteristics, but quite distinct in its seeds. The fruit is of indifferent quality.

ANONACEOUS FRUITS INTRODUCED TO CALIFORNIA

The most important members of the genus *Anona*, and several members of other genera of the *Anonaceae*, have all been introduced to California, but so far as known, none of them have yet attained sufficient size to produce fruit except the Cherimoya and the three doubtful species *Anona macrocarpa*, *A. reniformis* and *A. suavissima*. The following list includes all others known to have been introduced, some being of such recent introduction that they have not yet been tried out in the open, others, like the Sour Sop (*Anona muricata*) and the Sugar Apple (*A. squamosa*) have been repeatedly planted in various locations, only to succumb to the cool winters. It may yet be possible to fruit them by obtaining the hardiest types and planting them in the most favored locations.

Anona Cherimolia Mill., var. pyriformis

Indigenous to Chile.

Described as being hardier than most other Cherimoyas, and bearing pear-shaped fruits of large size and excellent quality. Recently introduced by the Bureau of Plant Industry.

Anona glabra Linn.

(*A. laurifolia* Dunal)

Southern Florida, Mexico, and the West Indies.

Known as *"Anona"* in Mexico; *"Cachiman Creme"* in the French West Indies; *"Pond Apple"* in Florida and the British West Indies.

A vigorous tree up to thirty feet in height, the trunk up to two feet in diameter. Leaves ovate-lanceolate, deep green above, pale green beneath, glabrous, coriaceous, persistent.

Fruit ovate-conical in shape, flattened at the base and rounded at the apex, two and a half to five inches long. Skin yellow or brownish yellow, sometimes reddish. Seeds conical, few. Pulp of a buttery consistency, very sweet, sometimes cloying.

Prof. Foex says this is the commonest anonaceous fruit on the markets of Mexico City, with the exception of the Cherimoya. It ripens throughout the year in the Mexican states of Chiapas, Guerrero, Jalisco, Michoacan, Oaxaca and Vera Cruz; from January to June in Puebla and other central states; from July to December in those states along the Pacific coast.

Although esteemed by the Mexicans, this fruit is not highly valued in Florida, where it is found in both fresh and salt water swamps. While it is found in Mexico at considerable altitudes it is not as hardy as the Cherimoya. Introduced to California by Dr. Franceschi. Only small plants are to be found as yet.

Anona montana MacFayden

Porto Rico, and other islands of the West Indies.

A small tree, bearing a sub-globose, muricate fruit, of little value. Introduced to Florida by Bureau of Plant Industry for trial as a stock for other Anonas.

Seeds sent to California in 1911 by Bureau of Plant Industry. Young plants raised by Dr. Franceschi were all killed during the first winter.

Anona muricata Linn.

(*A. asiatica* Linn.)

Cuba, Santo Domingo, Jamaica and several of the smaller islands of the West Indies, according to DeCandolle.

Known as *"Cabeza de Negro," "Catucho," "Guanabano,"* and *"Anona Amarilla"* in Mexico; *"Corossolier," "Cachiman Epineux,"* and *"Sappadille"* in the French colonies; *"Sour Sop"* in Florida and the British colonies.

Figure 133. A grove of Cherimoyas in the hacienda of "La Queseria," at the foot of the volcano of Colima, in Mexico, showing the conditions under which the Cherimoya frequently exists in that country.

A tree of about the same size as the Cherimoya. The leaves are ovate-lanceolate, acuminate, and glabrous. The foliage possesses a peculiar and distinctive fragrance.

Fruit very large (sometimes as much as ten pounds in weight), oblong, conical, or oval, and dark green in color. The skin is covered with short, pointed, recurved protuberances or weak spines. Pulp soft and juicy, but frequently fibrous or wooly and tasting of turpentine. Seeds slightly larger than those of the Cherimoya. The juice is acid or subacid, of pineapple flavor, and is widely used in the West Indies and other parts of the tropics for the preparation of a refreshing drink. The fruit matures throughout the year.

In many parts of the tropics choice varieties have been obtained, prolific and of fine flavor. It is well known that there is a great difference in quality in the produce of different trees.

The Sour Sop is one of the tenderest species of *Anona,* and is not known to have ever become established in California, although plants have been imported from Florida at numerous different times. Dr. Franceschi has raised seed from different sources, but with poor success. An importation from Paraguay in 1911, however, appears to be more robust and hardier, and may result in plants becoming established here. It is only by obtaining the hardiest varieties and planting them in the most favored localities that anything can ever be expected of this species.

Anona palustris Linn.

West Indies and South America, from Cuba to Rio Janeiro.

Known as *"Corcho"* in Mexico; *"Pomme de Serpent"* in the French West Indies; *"Alligator Apple"* and *"Cork Wood"* in the British West Indies.

An arborescent shrub, 10 to 15 feet high, the leaves ovate-elliptic or oblong, with short narrow point or sometimes bluntish, smooth on both sides, rather thick. The wood is sometimes used in place of cork.

Fruit two inches in diameter, yellow, somewhat roughened and scaly. Said to be narcotic, and for this reason not much used. Grows in swamps and along the seashore.

Of not much value as a fruit, but used in Florida as a stock for other Anonas. The difference in climatic conditions makes it doubtful if it will prove of value for this purpose here. Introduced from Florida in 1910 by Dr. Franceschi.

Anona reticulata Linn.

West Indies and tropical America.

Known as *"Anona," "Anauhtzapotl," "Anona Colorada,"* and *"Llama"* in Mexico; *"Cachiman," "Cachiman Coeur de Boeuf," "Corossol Reticule," "Corossol Sauvage,"* and *"Mamilier"* in the French colonies; *"Custard Apple"* in Florida; *"Custard Apple"* and *"Bullock's Heart"* in the British colonies.

One of the largest members of the genus, growing up to twenty-five feet in height. Leaves oblong-lanceolate, glabrous above, slightly pubescent and reddish below.

The fruit is described by Dunal as ovate-globose in form, but is better described by Prof. Foex as "the shape of an enormous strawberry." In color it is reddish brown or brownish yellow. The skin is not covered with protuberances or scales, the carpellary areas being defined by more or less distinct reticulations. The pulp is grayish or pinkish, and adheres to the rather numerous seeds. In flavor the Custard Apple is similar, but inferior, to the Cherimoya.

Prof. Foex remarks that by selection and crossing it would be possible to obtain varieties with pulp not adhering to the seeds, and of superior flavor and texture.

This species is common in the warmer parts of Mexico and in the West Indies. It is cultivated quite widely and has become naturalized in some places in southern Asia and western Africa. In Florida it has been grown for many years.

This species and *A. Cherimolia* have been greatly confused by California nurserymen and horticulturists in general, probably because of the fact that the Cherimoya has been commonly called "Custard Apple" in this state, and because the two species are somewhat similar, although they are entirely distinct in foliage and readily distinguishable by this means. *A. Cherimolia* has been listed under the name *A. reticulata* by some nurserymen, and others have listed the two as synonyms; but the plants disseminated have been of the species *Cherimolia* probably without exception.

Not as hardy as the Cherimoya, but might succeed in favored locations in this state. No plants of any size are known.

Anona squamosa Linn.

(*A. cinerea* Dunal)

According to DeCandolle, this species is indigenous to tropical America, and the West Indies in particular.

Figure 134. Another small grove of Cherimoyas in the hacienda "La Queseria." Note the similarity of the country to the dry foothill regions of Southern California.

Known as *"Anono," "Chirimoyo," "Saramuyo," "Texaltzapotl,"* and *"Anona Blanca"* in Mexico; *"Pomme Canelle"* and *"Attier"* in the French colonies; *"Sugar Apple"* and *"Sweet Sop"* in Florida and the British West Indies; *"Custard Apple"* in British India.

An arborescent shrub or a small tree, ten to fifteen feet in height. Trunk ashen gray, branches light gray. Deciduous in climates having a more or less marked dry or winter season. The foliage is strongly scented, and is sometimes used as an insecticide.

The fruit is normally round or conical, about the size of a small orange, and greenish in color. The surface is covered with prominent rounded protuberances, imbricated like the scales of a pine cone. The pulp is creamy, very sweet, and surrounds the rather numerous, medium sized, seeds.

The Sugar Apple is one of the finest of the Anonas, and is widely grown in tropical countries, in some of which it has become naturalized. It is ordinarily a more prolific and regular bearer than other species.

It has been planted in Southern California, but has not become established, having proved too tender for this climate. By obtaining the hardiest varieties from the Mexican highlands it may be possible to successfully grow it in favored localities. Dr. Franceschi believes it was first planted in this state about 20 years ago, having come from Florida.

Asimina triloba Dunal

United States, as far north as New York, and west to Michigan and Kansas; Mexico, south to the state of Jalisco.

Known as *"Papaw"* in the United States; *"Anonillo"* in Mexico.

A tree thirty to forty feet in height. The leaves obovate or oblong, acute, six to twelve inches long. Flowers 2 inches broad, purplish red.

Fruit oblong, two to six inches in length. Skin yellowish green, covered with a whitish bloom. The fruit greatly resembles the banana in its lack of acid and its fine grained pulp, but is of a peculiar and distinctive flavor. The pulp is light yellow in color, and contains two rows of seeds extending the length of the fruit.

The Papaw is occasionally found in cultivation, and has proved hardy as far north as Ontario. It is the hardiest of the anonaceous fruits, and the only one found in cold climates. Among the wild trees seedlings of superior quality are occasionally found, and the fruit could doubtless be greatly improved by selection. It offers a wide field for hybridization with other less hardy anonaceous fruits, and should also prove of value as a stock upon which to graft the more tender Anonas and Rollinias.

The Papaw was planted at Goleta, Santa Barbara County, many years ago by Joseph Sexton, one of California's pioneer nurserymen, but failed to establish itself. Repeated attempts to grow it were made, but with no success, due, as Mr. Sexton believes, to the hot and dry summers. Further attempts to grow it should be made, especially in cool and moist mountain canyons, where it should feel at home. Its greatest value probably lies, however, in the possibility of obtaining hybrids with other anonaceous fruits, or as a stock for them.

Rollinia emarginata Schlecht.

Brazil, Paraguay, and the northern part of Argentina.

"Aratacu-quatu." This is a small bush growing here in the open campo in almost any soil. The fruit is large and the best class of all, according to my thinking. *T. R. Gwynn.*

Recently introduced, under S. P. I. No. 27610.

Rollinia orthopetala A. DC.

Paraguay, Brazil and Argentina. *"Biriba."*

A tree, thirty to forty feet in height. Leaves oblong, acuminate, acute at the base, corolla one inch in diameter, greenish yellow.

Fruit size of an infant's head, greenish yellow. The flesh white and sweet.

Described by Prof. C. F. Baker as "the finest anonaceous fruit of tropical America."

"This is, as Prof. Baker wrote, the finest anonaceous fruit of tropical America. It is the only one of those which I have tasted that I liked, and on first trial I immediately pronounced it delicious. The seeds are embedded in a large quantity of pulp, which is of a custard-like consistency and of a very agreeable acidulous taste. I do not know what fruit it resembles most in taste." *Fischer.*

Introduced under S. P. I. Nos. 22512 and 27609. Rather tender, but may succeed in favored localities, where it is now being tested.

Wanted: A Genuine Southern California Park

RALPH D. CORNELL
LANDSCAPE GARDENER
LONG BEACH, CALIFORNIA

What could be more interesting and educational, to the people at large, than a public park devoted to plants indigenous to our dry and semi-arid lands, and representative of the many forms of plant life that are found along our coast slopes? A dry ground park, planted only to native trees, shrubs and flowers, would be one of the greatest possible assets to Southern California, and especially to the community whose park board was sufficiently aggressive and far seeing to establish such a system of planting. Not in all California can one find a collection of the native flora of sufficient consequence to warrant its recognition as such. Europe is far in advance of us in the cultivation of plants that grow wild on our dry hillsides, and unnoticed by us evolve, at our very doors, their wholesome lives of purity and beauty. Instances may be commonly cited where, unable to obtain reliable seeds at home, plant propagators have sent to Europe for seeds of flowers and shrubs growing wild on our own hills. It is true that many native plants and seeds are found in our markets, accessible to those who know, but the masses of people are unaware of the abundant wealth of flower and foliage, lying on all sides of us, inviting recognition and adoption.

Wild plants, when brought under cultivation, are prone to change their habits and appearance to a greater or less degree. The dignity of the move seems to demand that they put forth stronger efforts toward the perfection of their already inimitable charms. There are very few plants that do not improve under the more favorable conditions afforded them by protection and cultivation. The change is often so great that one familiar with a plant, in its native environment, will not recognize it in a new home.

Eastern residents, coming to California, find our parks quite similar to those which they are accustomed to seeing. With the exception of palms and a few things of more pronounced individuality, our evergreens, in general appearance, are not greatly unlike eastern plants, during their growing season, especially when planted in park form. The first mental impression upon visitors is the lasting impression, and there is little strikingly or distinctively characteristic in the landscape effect produced in our average park. A park should present a series of living pictures, in plant life, executed along the lines of greatest possibility. Not one person in a hundred distinguishes between a broad and a narrow leaved evergreen, or is sufficiently impressed by the individual specimen to give the name of a plant ten minutes later, had he recognized it at the time. It is the general tone of harmony or discord that leaves its effect upon the visitor, and that he remembers long after the details have been forgotten.

It seems to be our general tendency to make parks as artificial as possible, although one or two very commendable projects for developing natural parks are

Figure 135. Where in all the artificial surroundings of the conventional park can so inviting a path be found?

in progress locally. A city very often purchases dry hillsides or rugged slopes for park purposes. No sooner is this done than an elaborate water system is installed at enormous expense, and plants entirely foreign to such an environment are grotesquely perched where they must serve a life-long sentence of struggle for existence under conditions entirely adverse to their best development. Perhaps such productions are beautiful. They occur frequently enough. But surely they are far from natural, and do not produce a restful effect upon visitors. They act as a living advertisement of what man can do if he has time, water and ample funds, in sharp contrast to nature's own creations.

Now, why not plant dry hillsides in such a manner that they will produce maximum results at minimum expenditure? Plant a *dry ground park*. Use

Figure 136. A driveway through a grove of native oaks.

native plants already accustomed to the semi-arid conditions of our soil and climate. Such a park would be at once unique and individual; it would be decidedly typical and distinctive of California; it would be a garden spot of nature, a mecca for birds, a plant paradise; it would be a delight alike to the student, the botanist, the sight-seer and nature lover, each in his own way. If properly handled, it would become of world renown both among tourists and botanists; it would be the one place where those interested might go and see a collection of California plant life in its native environment; might study the habits of the individual, and see its fullest development under favorable conditions. There is no limit to the end that might be attained with such a park, if it were properly conducted. A descriptive booklet, obtainable on the grounds, would reveal to

Figure 137. Nature's wild abandon is well worthy, though difficult, of imitation.

all a life history of each plant. And this great possibility lies conveniently near, waiting only for a guiding hand.

Such selection of varieties could be made as to insure continual masses of flower or fruit. Spring would undoubtedly be the most gorgeous season, but by judicious selection and arrangement, a continuous wealth of color might be assured. By proper grouping, wonderful effects could be produced, while seeds of wild flowers sown broadcast among the larger plantings, would, each spring, form a gorgeous carpet of natural weave.

The moving of plants from their native haunts to the garden has not generally proven satisfactory, due probably to the extreme readjustment that becomes necessary. The easiest way is to raise the young plants from seed, thus assuring easy handling of the young stock and giving better opportunity for the proper

Figure 138. This beautiful creation—a credit to its designer—well illustrates the attractiveness of some of the more natural methods.

establishment of the root system. Little trouble is then experienced and success is practically assured. It does not stand to reason that these little seedlings could establish a foothold in dry soil, but if watered when planted, or set out during the rainy season and given a little attention for the first year, they would continue to thrive with the minimum of care, always responding, however, to cultivation of the soil.

Following are enumerated some few of the native trees and shrubs that should prove suitable for a dry ground park. The writer wishes to acknowledge the use of Abram's "Flora of Los Angeles and Vicinity" in his compilation of this list, and to thank Professor C. F. Baker, of Pomona College, for kind suggestions.

Figure 139. The sycamore is ever a picturesque feature of the Southern Californian landscape, with its intricate outline in winter and soft foliage in summer. One would like to tarry here and revel for awhile in the play of lights and shadows.

Adenostoma fasciculatum—Shrub 1-4 m. high, reddish branches and grayish bark. Common in the chaparral belt of our mountains. Flowering from April to June.

Arbutus Menziensii (Madrono)—Commonly 5-10 m. high. Found on Mt. Wilson and Sturtevant trails to 3000 feet, and in Los Tunas canyon of the Santa Ana Mountains.

Arctostaphylos (Manzanita)—Evergreen shrubs or small trees, all producing an abundance of bloom.

Arctostaphylos manzanita—Shrubby or arborescent, 2-8 m. high, bark mahogany red. Found in upper chaparral belt of our mountains.

Figure 140. A view into the Promised Land, a farm in the bosom of the hills, and surrounded by the choicest of "God's Acres."

Arctostaphylos patula—Diffusely branched shrub 1-1.5 m. high. Occasional on dry ridges and in open pine woods of San Antonio and San Bernardino mountains, 5000-8000 feet elevation.

Arctostaphylos tomentosa—Shrubby, erect, 1.5-3 m. high. Common in all our mountains in the upper chaparral belt.

Arctostaphylos glauca—Shrubby, erect, 3-6 m. high. Occasional in San Gabriel mountains, but more common in the San Antonio and San Bernardino ranges.

Arctostaphylos pringlei—Erect, branching shrub, 1.5-2 m. high. Occasional in the pine belt of the San Bernardino, San Jacinto and Cuyamaca mountains.

Figure 141. All the creative genius of man could not improve on some of the scenes along this delightful driveway.

Arctostaphylos bicolor—Shrub 1-2 m. high. Frequent in the foothills of western San Diego County, and also reported from Catalina.

Amorpha californica (Wild Indigo)—Shrub 1-3 m. high. Common in the chaparral belt.

Berberis dictyota—Shrub, 4-12 dm. high, with blue-black berries and attractive flowers. Found on the dry ridges near Glendale, Switzer's Trail and the San Gabriel mountains.

Berberis nevinii—Shrub, 2-3 m. high. Racemes are 4-7 flowered.

Ceanothus (California Lilac)—Common desert shrub with small but very showy flowers, generally fragrant and white, blue or purple.

Ceanothus integerrimus—Tall, loosely branching and sometimes arborescent. Flowers blue, varying to white. Frequent in the pine belt of all our mountains, and in the uppermost portions of the chaparral belt.

Ceanothus spinosus—Tall shrub or somewhat arborescent. Flowers pale blue. Found in the Santa Monica and Santa Ana mountains and north to Santa Barbara, in the canyons.

Ceanothus divaricatus—Shrub 1-2 m. high, flowers pale blue. Very common in the chaparral belt.

Ceanothus tomentosus—Shrub 2-4 m. high, flowers deep blue, or rarely white. Occasional in the chaparral belt of San Gabriel, San Bernardino and Cuyamaca mountains at an elevation of 3000-5000 feet.

Ceanothus sorediatus—Shrubby or somewhat arborescent, 2-4 m. high, flowers deep blue.

Ceanothus hirsutus—Shrubby or arborescent, 3-5 m. high, flowers deep blue to purplish. Frequent in the chaparral belt of the San Gabriel mountains, at an elevation of 2500-4500 feet.

Ceanothus macrocarpus—Shrubby, 2-3 m. high. Frequent in the Santa Monica and Santa Ana mountains.

Ceanothus cuneatus—Much resembles the last, but the branches are more rigid. Occasional along the southern rim of the San Gabriel and San Bernardino ranges.

Ceanothus crassifolius—Shrub 2-3 m. high. Common in the chaparral belt of all our mountains.

Cercocarpus betulaefolia (Mountain Mahogany)—Shrub or small tree, 2-5 m. high. Flowers in March, fruit in July.

Cupressus macrocarpa (Monterey Cypress)—Tall tree attaining a height of 100 feet.

Diplacus glutinosus (Common Yellow Monkey Flower)—Often called *Mimulus glutinosus*, but incorrectly so.

Diplacus longiflorus—Low, 5-10 dm. high. Common on all the foothills and in the chaparral belt.

Diplacus puniceus—Resembles the last in habit, but has scarlet corolla. Common on dry hillsides about San Diego and ranging northward to the Santa Margarita River.

Figure 142. Hesperoyucca whipplei. This is one of our most gorgeous desert plants, whose flower clusters would grandly illuminate a native park.

Eriodictyon californicum (Yerba Santa)—Shrub, 10-20 dm. high. Occasional in the chaparral belt of the San Gabriel mountains. More common on the dry plains east of our ranges, where it extends up to the pine belt. May-August.

Eriodictyon tomentosum—Shrub, 25-35 dm. high. Frequent in the chaparral belt of the San Gabriel and Santa Ana mountains.

Eriodictyon parryi—Stems, 8-18 dm. high. Occasional in the San Gabriel, Santa Ana and San Bernardino mountains, in the upper chaparral and lower pine belt. June-August.

Eriogonum fasciculatum (Wild Buckwheat)—Shrubby, 5 dm. or more high.

Fremontodendron californicum (Slippery Elm)—Branching shrub, or arborescent, 2-7 m. high. Frequent in the upper altitudes of the chaparral belt of our interior regions. June-July.

Garrya veatchii palmeri (Silk Tassel Tree)—Erect, branching shrub, 18-25 dm. high. Frequent in the upper portions of the chaparral belt of the San Antonio and Cuyamaca mountains. January.

Garrya veatchii undulata—Occasional on Mt. Wilson and Mt. Lowe.

Garrya pallida—Santa Ana mountains.

Heteromeles arbutifolia (Christmas Berry)—3-6 m. high. May-June.

Hesperoyucca whipplei (Spanish Bayonet)—Common in the chaparral belt of all our mountains.

Holodiscus discolor—Shrub 1-2 m. high, branches short, rigid, bark grayish brown, more or less shreddy. Sometimes called *Spiraea discolor*. Common in the chaparral belt.

Isomeris arborea—Widely branching shrub, 1-3 m. high, hard yellow branches and puberulent branches, yellow flowers, from February to July. Found along the bluffs and hills of the coast.

Isomeris arborea globosa—Similar to the above but with globose capsules.

Juniperus californica—Shrub, usually much branched. Common on the desert slopes.

Lepidospartum squamatum—Branching shrub, broomlike, 6-12 dm. high. Frequent in the dry washes of the interior valleys. July-October.

Libocedrus decurrens (Incense cedar)—A rather small tree of shapely habit, and great drought resistance.

Lotus glaber (Hosackia)—Tree 5-10 m. high, long yellow flowers, turning reddish. Common on our dry ranges, flowering the year around.

Lyonothamnus floribundus var. *asplenifolius* (Iron-wood)—Medium sized tree of beautiful foliage and great drought resistance. Found on Santa Cruz Island.

Lyonothamnus floribundus (Catalina iron-wood)—Similar to the last, but having a less serrated leaf. Also drought resistant. Native to Catalina Island.

Malvastrum davidsonii—Tall shrub, or arborescent, 2-4 m. high. Found in the San Fernando valley, and the La Canada washes.

Figure 143. The Monterey Cypress on its native heath, showing its appearance in full development.

Malvastrum fasciculatum—Tall shrub, or somewhat arborescent, 2.4 m. high. Common in the lower portions of the chaparral belt.

Mimulus brevipes—3-6 dm. high, corolla yellow. Flowering on our dry foothills from March to June.

Mirabilis californica (Four-o'clock)—3-6 dm. long. March-June.

Penstemon spectabilis—6-12 dm. high. Frequent on the dry hill sides. May-July.

Pinus torreyana (Del Mar or Torrey Pine)—Small tree, 6-10 m. high.

Pinus coulteri (Coulter's Pine)—Middle sized trees.

Pinus monophylla (Nut Pine)—Small tree, 5-8 m. high, with irregularly spreading branches and pale flaky bark. Frequent on the dry desert slopes of the San Gabriel and San Bernardino mountains.

Pinus attenuata—Small tree less than 10 m. high. Found on the southern slope of the San Bernardino mountains at 2500-4000 feet elevation.

Prunus demissa—Shrub, 1-4 m. high. Found in the chaparral and pine belt.

Cerasus ilicifolia (Evergreen Cherry)—Sometimes called *Prunus ilicifolia*. Shrubby or arborescent, 3-6 m. high. Flowering from May to June.

Prosopis juliflora (Mesquit)—Shrub or small tree, common on the Colorado Desert and along the river bottoms near San Bernardino.

Prosopis pubescens (Tornilla or Screw Bean)—Shrub or small tree. River bottoms about San Bernardino, with the last.

Quercus engelmanni—Middle sized tree. Altadena to Monrovia.

Quercus agrifolia (Common Life Oak)—Medium sized tree of spreading habit.

Quercus dumosa (Scrub Oak)—Shrub or small tree. Common in all the chaparral belt.

Quercus wislizeni—Spreading shrub or small tree. Common in the chaparral belt of all our mountains except the Santa Monica range.

Ramona nivea—Shrubby, below 9-12 dm. high. Occasional in the foothills of the Santa Monica and San Bernardino mountains. April-May.

Ramona stachyoides (Black Sage)—Common on the low hills throughout our range. April-June.

Ramona polystachya (White Sage)—Shrubby, below 1 m. high. Very common on the dry plains towards the foothills, and ascending these to about 3000 feet. April-July.

Rhamnus crocea—Low, much branched; flowers reddish. Occasional on the dry plains and in the chaparral belt of our interior regions.

Rhamnus crocea ilicifolia—Shrub, sometimes arborescent, foliage closely resembling *Cerasus ilicifolia*. Common throughout the chaparral belt.

Rhamnus californica (Wild Coffee)—Shrub, sometimes arborescent, 1-4 m. high. Common in the chaparral belt of all our mountains.

Rhus laurina—Shrub 2-4 m. high. Very common. June-July.

Rhus integrifolia Low evergreen shrub, 1-2 m. high, flowers white or rose colored, drupes very viscid and acid. Bluffs along the sea-shore. February-March.

Rhus ovata—Erect or spreading evergreen shrub, 1.5-3 m. high. Occasional in the chaparral belt. March and April.

Senecio douglasii—Usually about 1 m. high. Common on the dry plains and foothills, mostly below 3000 feet. July-November.

Sphacele calycina wallacei Shrubby at base, 6-9 dm. high. Occasional on all our mountains, especially in the upper portions of the chaparral belt, on the shady sides. May-June.

Symphoricarpos mollis (Snowberry or Wolfberry)—Low, much branched, about 3 dm. high. Chaparral belt of all our mountains and foothills.

Tetradymia comosa—Branches erect, elongated, 4-8 dm. high. Dry washes of the interior valleys. July-August.

Xylothermia montana Shrub 1-2 m. high, branches widely spreading.

Yucca arborescens (Joshua-tree)—Large yucca of the Mohave Desert.

Zauschneria californica micraphylla (Wild Fuchsia)—Frequent on dry hillsides, mostly below 3000 feet.

In addition to the plants listed above might be mentioned many varieties of the fleshes, such as the Cacti, stone crops, and Mesembrianthemums.

Most of the photographs used in this article were taken near the coast in middle western California, by J. M. Garrison, Palms, California.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II SEPTEMBER 1912 Number 3

A Stem Rot Disease of Carnations Due to a Species of Fusarium*

CLAYTON J. WIGHT

INTRODUCTION

In August, 1911, Mr. James McDonald of Alameda sent to the University Laboratory of Plant Pathology a diseased carnation plant (*Dianthus caryophyllus* L.) and reported that his plants were dying from some unknown cause. The stem of this diseased plant was placed in a box of moist sand and long curved spores of the Fusarium type developed upon it. This experiment formed the incentive which led to the investigation of the stem rot disease among the carnation growers in the vicinity of Oakland, Berkeley, and Richmond, and to a review of the literature upon the subject. The studies described in this paper have been carried on for the purpose of determining the nature of the disease, its extent, its remedy, and the relation of the disease organism to *Fusarium oxysporum*, a fungus which causes the dry rot of potatoes and is so fully described by Erwin F. Smith and Deane B. Swingle in Bulletin No. 55, of the Bureau of Plant Industry.

HISTORY OF THE "STEM ROT" DISEASE OF CARNATIONS

The carnation stem rot disease has been known among growers for many years, but it was not brought to the attention of plant pathologists until the latter part of the nineties, and comparatively little has been written about it.

In 1897 Wm. C. Sturgis, of the Connecticut Agricultural Experiment Station, observed the disease attacking the variety William Scott, which appeared to be more susceptible than others. He stated that the disease appeared first as a yellowing of the lower leaves and spread until it involved the whole plant. The cause of the disease was determined to be due to a species of *Fusarium* which gains access to the tissues at, or just below, the surface of the soil. The mycelium accumulated in the water ducts of the stem, thus preventing the free transfer of water. It was thought probable that the

*Prepared from Thesis submitted in partial fulfillment of the requirements for the Degree of Bachelor of Science, University of California, May, 1912. The original thesis is preserved in the Department of Agriculture, University of California, and contains two colored plates and other illustrations not included here.

disease could be communicated by cuttings and that the spores of the fungus were capable of retaining their vitality for several months. Sterilization of the soil when convenient, the use of cuttings from sound plants, and the immediate removal of diseased plants from the beds were recommended to prevent attacks of the disease. The Fusarium causing the disease was isolated in pure cultures, but only one form of spore developed, and it was fusiform, pointed at both ends, hyaline, slightly curved, 3-5 septate and measuring 25 u.*-38 u.×3.5 u.-4 u. These spores were borne singly or in small clusters, on the tips or sides of short branches of mycelium and, when seen in mass, they present a pale salmon pink color. A few inoculation experiments were tried. No infections were obtained by injecting Fusarium spores into incisions made on the plant. The inoculations made through the soil were indefinite.

In the same year the disease was brought to the attention of F. W. Card and J. E. Adams, of the Rhode Island Station. In 1898 they performed an experiment with fifteen hundred cuttings of a very susceptible variety (Flora Hill). Cuttings were grown in clean sand and in sand on which carnations had been previously grown. Chemical fertilizers and stable manures were compared, and the effect of dipping cuttings in Bordeaux mixture before planting was tried. The most marked results were obtained in the use of fresh, clean sand. Dipping the cuttings in Bordeaux mixture resulted in considerable loss. The general belief that the stable manure in the soil favors the progress of the disease was not sustained.

A more complete account of the disease and the organism causing it is given by L. Mangin and M. G. Delacroix of the Paris Academy of Science in No. 19, Vol. 129, and No. 23, Vol. 131, of Comptes Rendus.

In the fall of 1899, the disease was reported to be causing considerable damage to the fields of carnations at Nice, Provence, and Antibes. Mr. L. Mangin describes the disease as starting in the young stem and spreading out to the leaves, causing a serious decomposition of the stem, and a wilted and yellowish appearance of the leaves. The roots appear to be healthy. In a microscopical examination of the diseased stems, a large number of organisms were found in the decomposed, brown, and rotted areas, but only one was persistently found in the green tissues. This was a colorless mycelium extremely well developed in the cambium layer, and best observed in a thin longitudinal section of the stem. Parts of affected stems placed in a moist chamber became covered with a white mycelium and formed two varieties of conidia. The larger conidia were fusiform, curved, and often pointed; they are divided by transverse septa from 1-5, but ordinarily 3 in number. Their dimensions vary between 20 u. and 30 u. in length, by 2.5 u.-5 u. in width. The smaller spores were observed in the crevices of the stems and in the white areas of the rotted spots. These conidia were almost cylindrical, slightly curved, and rounded at the ends. They were 5 u.-12 u. in length by 2 u.-3 u. in width, and without septa. Chlamydospores developed in cultures fifty days old. These

*u used by typist for micromillimeters.

were most often formed at the extremity of short, thin, lateral branches of mycelium, but sometimes they were formed sessile on a filament. The mature chlamydospore is distinguished by its roughened surface; it is either white or of a light, yellow, brown color. In cultures exposed to the cold of winter certain mycelium filaments developed an elongated chlamydospore 30 u.-35 u. in length by 18 u. in diameter and with three or four cross septa. These chlamydospores germinated in sixteen hours in distilled water at a temperature of 22° C. In germinating they produced one or perhaps two filaments which perforated the exospore and were covered by the endospore. Very rarely a germinating chlamydospore produced a secondary spore which was round, yellow, thin walled and 9 u.-10 u. in diameter. No further studies of the secondary spores were made. The life of a chlamydospore does not appear to exceed a year. In one culture upon potato eleven months of age, the minority of the chlamydospores germinated. Mr. L. Mangin and Mr. E. Prillieux gave to this imperfect Ascomycete the name *Fusarium dianthi*. Later Mr. L. Mangin made further studies in which he demonstrated the parasitism of several species of Fusarium, including *F. roseolum*, *F. commutatum*, *F. roseum*, *F. aurantiacum*, *F. oxysporum* and *F. pyrochroum*. He concluded that the Fusarium of the carnation so closely resembled these other species that it should not be given a separate name.

Further observations in the field revealed that the disease was not of an infectious character, for diseased plants were often found isolated among healthy ones. The disease appeared to be a constitutional one, and some horticulturists made the remark that their plants were suffering from tuberculosis. The disease appeared to develop most rapidly at the time when the plant began to flower. In the examination of plants where the disease had just started, Mr. L. Mangin found mycelium bearing conidia in shoots absolutely healthy in appearance. Carnations grown under glass were more subject to infection than those grown in the free air, but plants grown under any condition were more or less subject to the disease.

The ordinary method of propagating the carnation was by means of cuttings and these seemed to be a source for the transmission of the disease. To prevent the spread of the disease in this way only cuttings from healthy plants should be used. In order to recognize these the prepared cuttings may be placed in the holes of a perforated board or metal plate and suspended over a vessel of water in such a way that the base of the cuttings will be two or three centimeters from the surface of the water. At the end of twenty-four hours at a temperature of 50° C., the ends of the diseased cuttings will be covered with a white mycelium, while the healthy ones will not show any infection. But to prevent the growth of any spores which may have lodged upon them, they should be washed in a weak solution of copper sulphate: one or two grams per liter may be used.

Another source of infection was by means of wounds, in which nematodes and spiders had an important part. The discovery of chlamydospores

in the soil, where diseased plants had grown, gave evidence that the fungus was also a soil fungus and might easily enter the plant through a wound. To avoid infection from the soil all diseased plants should be destroyed before the appearance of the conidia, a three-year rotation practiced, or the soil disinfected. The latter method was suggested for small farmers who would not be able to carry out a rotation of crops or for those who grew carnations under glass. Experiments were conducted with carbon bisulphide, sulphate of iron, formaldehyde and naphthol, from which it was found that all, with the exception of the last, would prevent the germination of the spores and the spread of the disease. Sulphate of iron cannot be used in soils containing much calcium carbonate, for it decomposes too quickly and does not kill the chlamydospores. Carbon bisulphide does not act very well in clay soils. Formaldehyde may be used under varying conditions.

FIELD OBSERVATIONS

In making the field observations thirteen nurseries were visited where carnations are being grown on a commercial scale. These nurseries are situated in Elmhurst, Melrose, Berkeley, and Richmond, and are owned by Americans, Germans, Japanese, and Italians. The data obtained largely corroborate that given by Mr. L. Mangin in the foregoing pages. The activity of the disease appears to be directly dependent upon cultural conditions, and it is necessary to have a complete knowledge of the propagation of the carnation in order to understand the relation of the disease to the plant.

The carnation is commonly propagated by means of cuttings. The cuttings are obtained by removing suckers or shoots, three or four inches in length, from mature plants; the base or heel of a cutting is cut off squarely beneath a node, the lower leaves are entirely removed, and the ends of the longer ones are usually clipped. In this locality cuttings are started between the first of January and the first of March; they are rooted by being placed about one inch apart in boxes of sand, and kept in the propagating house until a root system has developed, which is about one month. The cuttings are then transplanted to other boxes or pots containing ordinary soil, where they are set four to six inches apart each way. They are kept under glass until April or May, then they are moved outside, either in boxes or transplanted to the ground, where they remain until moved into the houses used for the production of cut flowers. The final transplanting is done in July or August, and the plants are placed from ten to fourteen inches apart each way. During the colder months the houses are heated by steam; a temperature of 65 degrees to 70 degrees F. is maintained during the day and 45 degrees F. to 55 degrees F. during the night. On very warm days the temperature may rise above 70 degrees F., but the grower makes every effort to keep it below 80 degrees F., by the use of ventilators and overhead irrigation. Carnations will not thrive well

in a hot, humid atmosphere. Each year the growers change the soil in their green-houses so as to secure soil rich in plant food and freer of disease organisms.

The stem-rot disease, which is due to a species of Fusarium, may make an attack at any time during the life of the plant, but it is more serious at certain stages in its propagation, that is, at such times when the plant has to submit to rather sharp changes in conditions of moisture or temperature, thus weakening its natural vitality. There are three such periods in the life of the plant which are well marked. The first and probably the most critical one comes when the plant is "benched," that is, when it is transplanted from the outdoor beds into the green-house. A few warm, cloudy days, on over-moist soil, or too deep setting of the plants are conditions which favor the development of stem-rot. The second critical period comes when the steam heat is turned on in the autumn; again the plants may be subjected to a rather sharp change in temperature. The third and last critical period comes in the spring, when the temperature gets abnormally high and the plant is low in vitality from having been forced during the year in the production of flowers.

As Mr. L. Mangin has observed, the diseased plants are recognized by the wilted, yellowish, drying-up condition of the foliage and a softened condition of the stem at the surface of the ground. In the early stages of the disease the roots and upper portions of the branches are sound, while the intervening portion will show brown and blackened areas. Frequently one or two branches become affected and wilt before the remainder of the plant shows any signs of the disease (Plate 1). However, it eventually spreads upward and downward until the whole plant is in a more or less advanced stage of decay. The roots become thoroughly decomposed and rot off: the stem and its branches become dry and brittle, characteristic of dry rot. Upon a plant where the disease is fairly well advanced, small flesh- or salmon-colored clusters of spores are often found. A microscopical examination of them reveals the presence of the characteristic curved Fusarium macroconidia. A similar examination of the tissue of the affected stems shows the presence of abundant mycelium in the parenchyma cells, although the upper branches and the roots of the plants are apparently in a perfectly healthy condition. The progress of the disease is normally slow, but in an exceptionally warm and moist atmosphere, the disease organism may destroy tissue very rapidly, as pointed out by the descriptions of inoculated plants in another part of this paper. It is probable that some diseased plants continue to produce flowers for months after they are infected. Growers report that some varieties are more susceptible than others, and the following kinds have been mentioned by several as being among the most susceptible:—Enchantress, Prosperity, Winsor, Perfection, and Nelson Fisher.

PLATE I

The method by which the fungus obtains entrance into the plant stem has not been entirely determined, but it doubtless gains entrance through a wound or by first establishing itself upon dead or inactive tissue and then penetrating the living tissue. At every stage in the growth of the carnation there is more or less idle tissue upon it. The cutting in starting its growth develops new leaves from the center, the outer ones remain green for a time and finally die. These outer leaves, if at all moist, afford an excellent means for the entrance of the fungus into the inner tender tissues of the plant. The carnation stem frequently checks, thus forming easy passageways to its interior and deadened areas formed on the margins of the checks may give the fungus a foothold. When the flowers are cut they are not necessarily cut at a node, and if they are not the portion of the stem extending beyond the node dies; in fact, such a stem often dies back to a main branch. All of these dead parts and bruises afford an opportunity for the disease organism to enter the plant. The fungus is undoubtedly parasitic under favorable conditions.

Stems of diseased carnation plants placed in moist chambers rapidly develop tufts of mycelium on their surfaces which originate from filaments which have broken through the epidermis of the stem or from clusters of spores formed on the outside of the stem. These tufts of mycelium are 5-10 mm. high, usually white, but sometimes they are pink or yellow in color. Macroconidia develop in them, and a pure culture could be easily obtained by simply touching one of these tufts with a sterile platinum needle and transferring the spores to a poured plate.

DESCRIPTION OF THE FUNGUS

The mycelium found in diseased plants is colorless, slightly more slender than that grown in cultures, much branched in the parenchyma and with frequent septa. The septa are 5 u. to 10 u. apart and the mycelium varies in width from 3.5 u. to 6 u. No microconidia have ever been found, either borne within the host, or developed in cultures. The fungus was obtained in pure cultures from three different sources: Alameda, Richmond, and Elmhurst. One strain was established from a single spore, this spore was taken from the Elmhurst culture. A careful study of each strain was made in drop cultures of beef extract bouillon (M1). The Van Tieghem cell was used for these studies. The macroconidia germinated in less than twenty-four hours; some germinated from the end cells and some from the central cells of the spore (Plate V, Figures 6 and 7). In forty-eight hours quite a profuse mycelium had formed, and it had grown across drops two and three millimeters in diameter. At the end of seven days the formation of macroconidia began; these were the only variety of spores developed in drop cultures. They were formed most rapidly in places where the mycelium came in contact with the glass outside of the drop; such contact seemed to stimulate the formation of spores. The macroconidia

are formed by being cut off from the ends of hyphal branches. Sometimes a spore is cut off from the end of a terminal branch, but more commonly from the ends of short lateral branches by a constriction furrow. As soon as one macroconidium is cut off, the hypha begins to elongate, pushing past it and soon forming a second constriction furrow, which cuts off a second macroconidium. This process continues until sometimes eight or ten macroconidia are formed from a single branch and lie side by side in a little group. Sometimes the septa are formed in the macroconidia before they are cut off but more frequently afterwards (Plate V. Figures 1, 2, and 3).

The exact time required for the formation of the macroconidia has not been determined, but the process must be very rapid, for hundreds will develop in a single spore drop within two or three days after they have started to form. The macroconidia vary in length from 25 u.-60 u. and in width from 4 u.-5 u. When these conidia are first formed they are cylindrical in shape, rounded at the ends and nearly straight. With age they become much more pointed at the ends and more curved. They are from one to six septate, usually three or four; they are seldom constricted at the septa. Macroconidia formed upon the plant in the open are

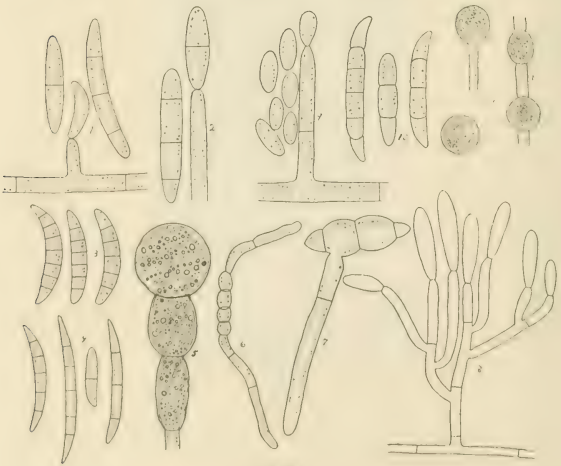


PLATE V

much more slender than those developed in cultures (Plate V. Figure 4).

The chlamydospores are produced as swellings of the mycelium, usually intercalary, and there are often several on the same hypha close together like a string of beads. They are circular or ovate cylindrical and appear to have two walls; those which are ovate cylindrical in shape are sometimes divided by transverse walls. They have a slightly uneven surface and are yellowish brown in color. The size of the spherical ones varies from 10 u. -20 u. in diameter, and the oblong ones from 8 u.-10 u. in diameter by 20 u.-25 u. in length. They were filled with very large granules of protoplasm. (Plate V. Figure 5.) Strain (E) formed an abundance of them in nutrient agar in thirty days.

GROWTH ON DIFFERENT MEDIA

In making a study of the cultural characters the three strains of carnation Fusarium previously mentioned were used, and in addition two strains of potato Fusarium have been studied in parallel cultures, for the purpose of making comparisons between the carnation and potato strains. One of the potato strains was received from Dr. M. T. Cook of the Delaware Experiment Station, and considered by him to be *Fusarium oxysporum;* morphologically it corresponds to the description of *F. oxysporum* given by Erwin F. Smith and Deane B. Swingle in Bulletin No. 55 of the Bureau of Plant Industry, but in cultural habits it differs from the descriptions given, for it has a depressed growth on most media and the *F. oxysporum* described in the bulletin has an aerial growth on most media. The other potato strain was isolated from the stems of diseased potato plants growing in the horticultural garden of the University. All of the cultures of it have originated from a single spore, and in cultural and morphological characters this Fusarium corresponds very closely to *F. oxysporum,* as described in the bulletin mentioned above. Its parasitism has not, however, been satisfactorily confirmed, either by observation in the field or by inoculation experiments. For convenience in describing the cultural characters and the accounts of inoculation experiments with the different strains, symbols will be used. The symbols (R), (E), and (IV) refer to carnation strains obtained from Richmond, Elmhurst, and Alameda, respectively; (H) refers to the potato strain received from Delaware, and (VII) to the potato strain isolated from potato plants in the University garden.

A detailed description of the various culture media used appears in another part of this paper. P. 330. Three kinds of glass vessels were used: 200 c. c. Erlenmeyer flasks, 70 mm. in diameter through their widest part, test tubes 20 mm. in diameter, and petri dishes 90 mm. in diameter. All transfers were made with a sterile platinum needle and the plantings were made as nearly as possible in the center of each container. The cultures were always made in duplicate and often in series of four or six. In almost every instance growth was apparent to the naked eye in forty-eight hours.

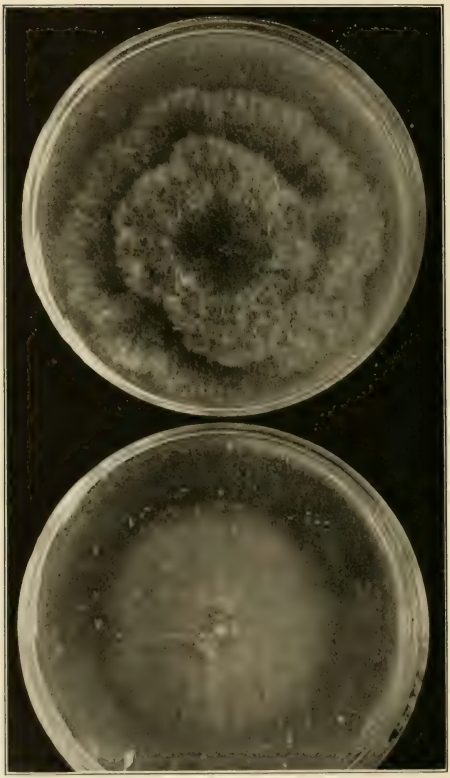


PLATE II. Figures 1 and 2.

PLATE III. Figures 1 and 2.

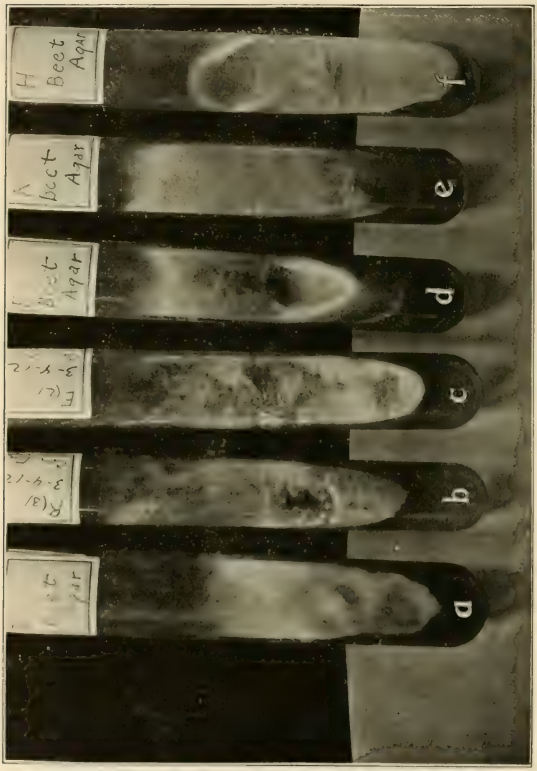


PLATE IV

Unless otherwise stated the cultures were kept in a glass case in the interior of the laboratory. The descriptions are given for reflected light and a white ground.

Nutrient agar (M4). The descriptions are given for plate cultures. Carnation strains of Fusarium grew vigorously, developing a light cottony growth. A culture normally increased its diameter 10 mm. each 24 hours. Growth was always accompanied by the development of color of varying density. Strain (E) developed color more profusely than the other strains; first a wine red color developed which appeared most intense in the two concentric zones corresponding to the zones of greatest mycelium growth. (Plate II. Figure 2 and Plate IV. c.) Older cultures developed a sulphur yellow color irregularly over the plate. Strain (R) developed the same colors in a less degree, and strain (IV) sometimes produced the red or pink tinges, but usually only a slight yellow coloration was observed. (Plate III. Figures 1 and 2, and Plate IV, b.)

The potato strains grew less rapidly; a culture increased its diameter about 7 mm. per day. A slight yellowish color appeared about the twelfth or fifteenth day. Strain (H) always formed a depressed growth and concentric and radial lines were often prominent. (Plate II, Figure 1.) Strain (VII) always formed a cottony growth about 4 mm. high and sometimes sufficiently uneven to give the effect of concentric rings.

Nutrient agar (M3). Growth of the various strains on this medium closely resembled the growth on (M4), except in color which developed less readily.

Beet agar (M2). The descriptions are given for slant tube cultures. The carnation strains closely resembled each other in growth; each produced a vigorous cottony mycelium, accompanied from the beginning by the development of a wine red color, and in three to five days by the development of a sulphur yellow color. Cultures thirty days old developed a copper green amidst the yellow. A dense pellicle formed on the surface of the slant. This was deep blood red below and shaded into lighter tints of wine red above. The center of the culture was yellow and green, and the aerial growth extending above the tip of the slant remained white. (Plate IV. Figures a, d and e.)

The potato strains differed in their growth. Strain (H) formed a depressed growth, very pale salmon in color, except for a slight cottony growth extending above the upper tip of the slant. (Plate IV. Figure f.) Strain (VII) formed a cottony mycelium about 4 mm. high, slightly rose pink, and a thin pellicle shading from rose pink below to creamy yellow above.

Prune juice and bread (M5). The descriptions are given for flask cultures. Carnation strains were very similar in growth, each producing an even cottony mycelium about 10 mm. high and spreading over the surface of the medium in ten or twelve days. Color developed about the tenth day.

In most cultures the lemon yellow color appeared first, although in some, yellow and red colors developed almost simultaneously. In cultures thirty to forty days old the red tones became more pronounced than the yellow. A thick pellicle formed over the surface of the medium, and wherever it touched the glass its color was very striking, being a deep crimson below and shading into the lighter tints of wine red above.

The potato strains grew only one-half as rapidly as the carnation strains on this medium, and it required about twenty days for a culture to spread over its surface. Strain (VII) developed a dense cottony growth 4-6 mm. high. In a direct north light a rose red color began to appear in ten days; in an interior glass case, the rose red color did not appear until the cultures were thirty days old. No distinctive color developed in cultures kept in darkness. Strain (II) grew depressed or with a cottony growth of a ropy nature. Cultures kept in north light developed a rose red color, but those kept in darkness did not develop any color.

Steamed white corn meal (M6). The descriptions are given for flask cultures. The carnation strains resemble each other in cultural characters on this medium also. In ten days the surface of the medium became covered with a cottony growth 10 mm. in height. The usual wine red color began developing in three or four days, which was followed by the appearance of the lemon yellow tints. The two colors became mingled throughout the culture, and they gradually increased in intensity with age, until reaching a maximum intensity in cultures thirty days old. Numerous rich salmon-colored bodies developed in cultures of that age. A thick wine red pellicle formed over the surface of the medium. In places the mycelium penetrated beneath the pellicle between the glass and the medium, and it is probable that the mycelium is capable of penetrating all through the substratum.

The potato strains grew less rapidly, requiring twice as much time for a culture to spread over the medium. The growth of strain (VII) was dense, cottony, and 5-7 mm. high; no coloration could be detected until the cultures were twenty-five days old, then a faint rose pink color appeared which developed slowly. A thin pellicle formed at the surface of the medium, and no mycelium had penetrated any part of the substratum in cultures sixty days old. The growth of strain (II) was mostly depressed, the little cottony growth that appeared was of a ropy character. A deep lilac color developed from the beginning which later became overspread with a yellowish brown, but if any secondary growth developed the lilac color again appeared. In cultures thirty to forty days old the surface stratum became wrinkled and the mycelium did not penetrate the substratum.

Steamed rice (M7). The descriptions are given for 200 c. c. flasks. The carnation strains all grew vigorously on this medium, developing a cottony growth 10 mm. high, and particularly delicate colors. Strains (E) and (R) began developing a lemon yellow color and strain (IV) a wine red color in three days. A few days later all strains developed both colors;

strains (IV) and (R) developed them in equal intensity, but in strain (E) the pink was scarcely noticeable. This difference in the formation of color gave the (E) strain a distinctly different appearance from the other two.

The potato strains grew more slowly than the carnation strains. Strain (VII) produced a dense cottony growth about 4 mm. high and began forming a rose pink color in twenty-five days, but this color did not become very intense even in cultures sixty days old. The growth of strain (II) was mostly depressed, the ropy cottony character appeared only in the secondary growth. The first growth was accompanied by the development of an intense lilac color, which later faded to a pale salmon. A pellicle formed over the surface stratum and folded itself about the rice kernels in such a way as to give the culture a very wrinkled appearance. The mycelium filaments of both potato and carnation strains penetrated the substratum and developed their characteristic colors.

Steamed potato plugs (M8). The carnation strains developed a vigorous cottony growth covering the entire plug of each culture in seven days. The usual wine red color appeared the fourth or fifth day, being densest in the pellicle covering the plug and shading to lighter tones in the aerial growth. A sulphur yellow color began developing in twelve to fifteen days and various shades of green appeared in cultures about fifty days old. The colors developed in darkness as readily as in light. The mycelial filaments often extended 20-25 mm. above the tip of the plug, but were without color.

The potato strains grew more slowly, and the cottony growth did not attain such a height as in the carnation cultures. Both strains formed a dense even growth 4-6 mm. high. A rose pink color appeared in eight to ten days in cultures kept in a north window; this color increased in density until it became a rich salmon. Small green sclerotia were observed in a culture of strain (VII) fifty days old. No appreciable color developed in darkness. Both the potato and carnation strains were capable of penetrating through the plugs.

Steamed beet plugs (M9). The growth of the different strains on this medium was very similar to the growth of the respective strains on steamed potato plugs. The carnation strains developed color a little more rapidly and with a little greater intensity. The potato strains did not grow so well; strain (VII) was less dense and only 2-3 mm. high, and strain (H) was always depressed or in ropy masses.

Raw potato plugs (M10). Only one carnation strain and one potato strain were grown upon this medium. The growth of each was very similar to the growth of the respective strains on steamed plugs. The same colors developed in both light and darkness. Strain (II) grew less rapidly than on steamed plugs, but developed color equally well. It should be noted that the method used in preparing these plugs probably killed many of the surface cells of the potato, thus facilitating the growth of the fungi.

General culture characters. No disagreeable odor developed in any of the cultures; whenever any odor could be detected, it was of a pleasant rather than of a disagreeable nature. Some coloration appeared in all cultures kept in the light. All cultures formed spores; they were most abundant in old cultures or in cultures with little available food. Very few chlamydospores formed in the flask cultures.

COMPARISON OF THE CARNATION AND POTATO STRAINS

The description of the cultural characters for the different media have shown that the carnation Fusarium is a much more vigorous grower than the potato Fusarium, producing a stronger stroma, a higher aerial mycelium and also in producing a distinctive yellow color differing from any which appeared in the potato Fusarium cultures. A morphological difference occurs in the spores. The carnation strains develop very few conidia which could be classified as microconidia. The four- to six-celled curved macroconidia is the type universally found. On the other hand the potato strains develop oblong to cylindrical microconidia in great abundance, and comparatively few of the true Fusarium macroconidia. The potato and carnation strains form chlamydospores differing greatly in appearance. The carnation strains form large yellowish brown chlamydospores 10 u.-20 u. in diameter; some are spherical, others are oblong and divided by transverse walls. All contain very large granules of protoplasm. The potato strains form light brown chlamydospores, most of which are spherical and only 6 u.-12 u. in diameter. They are filled with much smaller granules of protoplasm and all are one-celled. (Plate V. Figures 5 and 11, a, b, c.)

CULTURE MEDIA USED

The composition of the different cultural media used in the studies of the various species of Fusarium fungi are given in the following descriptions.

Beef extract bouillon (M1). This medium consisted of the following materials:

Peptone	1%—5 grams
Beef extract	0.5%—2.5 grams
Common salt	0.5%—2.5 grams
Distilled water	500 c. c.

These ingredients were dissolved in nearly the full amount of water, boiled a few minutes, enough distilled water added to make the total 500 c. c., and filtered twice through absorbent cotton.

Sugar beet agar (M2). A large, sound sugar beet was thoroughly scrubbed, washed in distilled water, pared, and cut up in fine pieces. To 400 grams of beet was added 1000 c. c. of distilled water, and the whole was heated until the pieces of beet could be easily crushed into a pulp, then filtered through a clean towel. Four grams of thread agar were dissolved and added to the beet liquid with enough distilled water to bring the total up to 800 c. c. The medium was then filtered through absorbent cotton,

heated in the steam sterilizer for one hour, and sterilized for thirty minutes on three successive days.

Nutrient agar (M3.) This medium consisted of the following materials:

Agar-agar	1.2%—3 grams
Peptone	1.0%—2.5 grams
Salt	0.5%—1.25 grams
Beef extract	0.5%—1.25 grams
Distilled water	250 c. c.

Thread agar was soaked in tap water for thirty minutes, washed in distilled water and boiled in nearly the full amount of water until thoroughly dissolved. The other ingredients were then added, the whole made up to 250 c. c. with distilled water, filtered through absorbent cotton, and sterilized for twenty minutes on three successive days.

Nutrient agar (M4). This medium consisted of the same materials as (M3), prepared in the same manner except 1.25 grams of dextrose was used in place of 1.25 grams of beef extract.

Prune juice and bread (M5). Seventy grams of dried prunes were washed carefully in tap water, rinsed in distilled water and cooked slowly in distilled water until the prunes were thoroughly softened. The fleshy part of the prunes was mashed into a pulp, enough distilled water added to bring the total up to 500 c. c., strained through a clean towel and the liquid filtered through absorbent cotton. About 25 c. c. of this liquid was put into each 200 c. c. flask and sufficient bread crumbs added to soak up the liquid. The flasks were sterilized for twenty minutes on three successive days.

Steamed white corn meal (M6). Ten grams of meal and 35 c. c. of distilled water were used for each 200 c. c. flask. This medium was sterilized for thirty minutes on three successive days.

Steamed rice (M7). Ten grams of rice and 40 c. c. of distilled water were used for each 200 c. c. flask. This medium was sterilized for thirty minutes on three successive days.

Steamed potato plugs (M8). Large, sound potatoes were thoroughly scrubbed, washed and cut into cylinders about 1½ inches long and one-half inch in diameter with a large cork borer. These cylinders were cut lengthwise diagonally, thus each cylinder made two plugs with slant surfaces. These plugs were washed in running water twelve hours, rinsed twice in distilled water and sterilized for twenty minutes on three successive days.

Raw potato plugs (M9). These plugs were prepared in the same manner as the steamed plugs, except they were washed in 4% formalin solution, rinsed several times in distilled water and not sterilized.

Steamed beet plugs (M10). A large, sound beet was thoroughly scrubbed, washed and prepared in the same manner as the steamed potato plugs, but not washed in running water.

INOCULATION EXPERIMENTS

These experiments were carried on in order to determine the parasitic nature of the different strains of Fusarium studied; and to determine if strains isolated from the carnation were capable of producing disease in the potato, and vice versa to determine if potato strains were capable of producing disease in the carnation. The plants used in the experiments were kept in one of the University of California greenhouses, and unless otherwise stated, they were given ordinary treatment. Two methods of inoculation have been tried. The first consisted in simply burying pure cultures of the strain under investigation in the soil, and in contact with the stem of the plant. The second consisted in making a narrow slit, with a sterile knife, in the stem of the plant, even with the surface of the ground, placing the spores and mycelium of a pure culture in it, and sealing the wound with paraffin. The details of each experiment follow:—

February 5th—Two Prosperity carnation plants, about six weeks old, were inoculated by the first method. One plant was inoculated with a pure culture of strain (IV) and the other with a pure culture of strain (VII). Neither plant became infected with the disease. Two other plants of the same variety were kept under similar conditions for control.

February 21st—Two Enchantress carnation plants, twelve weeks old, were inoculated with strains (IV) and (VII), respectively, by means of the "slit" method. In eleven days the plant inoculated with strain (IV) wilted, its foliage had a yellowish cast, and its stem was affected with the disease. An examination of the stem beneath the paraffin revealed the presence of freshly developed spores and mycelium. The plant inoculated with strain (VII) remained normal. Two plants of the same variety were used for control and given the same treatment, except that their stems were not cut and sealed with paraffin.

February 21st—Three carnation plants of the Estelle variety, about one year of age, were inoculated with pure cultures of strains (IV), (VII), and (H), respectively, by the "slit" method. These inoculations were not successful.

March 7th—An Enchantress carnation, about one year of age, was inoculated with a pure culture of strain (R) by the "slit" method. The progress of the disease in this plant was slow, and no signs of injury were noticed until April 5th, then the lower branches became yellowish and one side of the stem was affected with a dry rot. On April 15th the plant, although it was not dead, was removed from its pot and a microscopical examination made of the diseased tissues of the stem. One-half of the stem was decayed at the point of infection, and, with the exception of a slender brown streak, consisting of broken-down parenchyma tissue, the decay extended only about one and one-fourth inches above and below this point. An abundance of mycelium could be observed in cross sections of the decayed and partially-decayed areas. Segments of the affected stem

placed in a moist chamber developed from their ends a profuse white mycelium bearing Fusarium macroconidia. Another plant of the same variety was used for control; it was given the same treatment except for the slit and paraffin seal. It did not become diseased.

March 7th—Two Enchantress carnation plants, fourteen weeks of age, were inoculated with pure cultures of strain (R) by the "slit" method. The pots containing these plants were placed in larger pots and covered with window glass, thus providing a more humid atmosphere for the development of the fungus. Within four weeks one of the plants became seriously diseased, an abundance of flesh-colored clusters of spores developed on the outside of the stem and mycelium was found in the tissues. The other plant became infested with various organisms, and no definite result was obtained. Control plants kept under the same conditions did not become diseased.

March 3rd—A one-year-old Enchantress carnation plant was inoculated with a pure culture of the (R) strain by the "slit" method and kept under a bell jar. On April 2nd the lower branches of the plant became wilted and pale yellow in appearance. On April 5th the entire foliage of the plant presented a wilted yellowish appearance, very characteristic of the stem-rot or wilt disease. Its stem, for a distance of one inch above and below the point of infection, was thoroughly decomposed. An examination of a cross-section of the diseased portion showed the presence of abundant mycelium and for the first time Fusarium macroconidia were found borne in the living cells. This stem also contained a small brown streak of broken-down parenchyma cells, extending above the zone containing mycelium. The continued presence of such brown areas without mycelium in both artificially and naturally diseased plants seems to indicate that the plant tissue is destroyed in some way in advance of the mycelium. Segments of the diseased stem of this plant, placed in a moist chamber, developed a profuse white mycelium at their ends also. A plant of the same variety and receiving exactly the same treatment, except for the inoculation, did not become diseased.

April 3rd—Two Prosperity carnation plants, about twelve weeks old, were inoculated with strains (IV) and (VII), respectively, by putting an abundance of the pure culture material into the soil and in contact with the stems of the plants. These plants were kept under bell jars and control plants were kept under similar conditions. These plants gave no indications of disease on May 1st.

April 3rd—Three potato plants, which were just beginning to form potatoes, were inoculated with strains (IV), (VII) and (II), respectively, by the "slit and paraffin" method. Each pot contained two plants, one being used for a control. These plants were kept under bell jars. These inoculations were not successful.

March 4th—Inoculation of mature, sound potatoes. These potatoes were prepared by being thoroughly scrubbed in tap water, washed in a four per cent solution of formalin, rinsed several times in distilled water, placed in sterile glass chambers and kept one week before being inoculated. Three chambers were prepared in this way and inoculated with strains (R), (VII), and (H) respectively, by means of an incision in the potato. The potatoes were examined April 20th. The fungus grew in each instance, but none of the strains were able to penetrate the potato any appreciable distance.

REMEDIAL MEASURES

The field observations have shown that the carnation stem-rot disease is not serious, probably not more than one-half of one per cent, or one per cent loss occurs from it; yet almost every grower who has been growing carnations for ten or fifteen years remembers a time when the disease was of a serious nature. A reason for the lesser activity of the disease has not been determined, but it is probable that more resistant varieties are now grown and that the methods of culture have been improved. At present the control of the disease can almost entirely be obtained by observing the most improved cultural methods. Many of the suggestions given here are those practiced by the most intelligent growers in this vicinity. They are simple and do not involve any extra expense in their application. Always select vigorous cuttings from thrifty, healthy plants. Use a sharp knife in preparing the cutting, in order to secure clean cuts; carefully remove all leaves from that portion of the cutting, which, when planted, comes in contact with the soil. Do not use the same soil more than one season. A change of soil is not only a preventive measure against disease, but favors the growth of a more vigorous and productive plant. Avoid, as far as possible, sudden changes in temperatures and moisture, particularly high temperatures and extreme dampness. Provide for a free circulation of air about the plants. When transplanting, be careful not to injure the plants and do not set them too deep, i. e., do not allow any part of the stem to come in contact with the soil which was not formerly in contact with it. Irrigate the beds in the morning, in order that the leaves of the plants and the surface soil may become dry before night. When infected plants are observed, remove them from the beds and destroy them. Grow the varieties which experience in a given locality or soil has shown to be the most resistant, provided such varieties meet the demands of the market. The disease is not serious enough to warrant the selection of a variety which is not of the best market type. The grower who observes these simple but essential rules in culture need not fear any serious trouble with the stem-rot disease.

SUMMARY

1. The carnation Fusarium differs in cultural and morphological characters from *Fusarium oxysporum*.

a. It does not form microconidia, its chlamydospores are more deeply colored, and twice as large as those of *F. oxysporum*.

b. It is a more vigorous grower than *F. oxysporum* and in cultures a distinct yellow color appeared which did not appear in cultures of *F. oxysporum*

2. This fungus is capable of invading a carnation plant through a wound and causing disease.

3. This fungus is not likely to cause injury to a sound plant through soil infection.

4. It is evident that the infected plant dies as a result of the invasion of the fungus, but not from having its water ducts clogged by the mycelium.

5. The disease of carnation stem-rot or wilt is widely distributed in this vicinity but not serious.

6. The disease may be adequately controlled by the application of the proper cultural methods.

a. Use only cuttings from healthy plants.

b. Change the soil in which the plants are grown each year.

c. Guard against extreme heat and moisture conditions.

d. Be careful not to injure the plant when transplanting it.

BIBLIOGRAPHY

Britton, W. E.: American Florist, Vol. 14 (1898); No. 545, pp. 431-432.

Britton, W. E.: Gardening, Vol. 7 (1899), No. 153, p. 138.

Card, F. W. and Adams, G. E., Rhode Island Report:
1899, p. 131-135—Extract E. S. R., Vol. 12, p. 763;
1900, p. 249-251—Extract E. S. R., Vol. 12. p. 966;
1901, p. 233-234—Extract E. S. R., Vol. 13, p. 763.

Scribners, Vol. 19, p. 313.

Current Literature, Vol. 29, p. 214.

Current Literature, Vol. 37, p. 478.

Stone, G. E., and Smith, R. E.: Mass. Reports for 1901, pp. 66-69.
Extract E. S. R., Vol. 14, p. 157.

Sturgis, W. C.: Conn. State Station Report (1897), pp. 175-181.
Extract E. S. R., Vol. X, p. 262.

Stewart, F. C.: Botanical Gazette. No. 27 (1899), No. 2, pp. 129-130.
Same E. S. R., Vol. X, pp. 1054-1055.

Duggar, B. M., Text: Fungous Diseases of Plants, p. 321.

Atkinson, Geo. F.: American Florist, 8; pp. 720-728 (1893).

Mangin, L.: Comptes Rendus, Academy Science, Paris, Vol. 121 (1900), pp. 1244-1246.
Extract E. S. R., Vol. 13, p. 154.

Description of Plates

PLATE I. Carnation plant in which the shoots on the right appear healthy, and those on the left are affected by the Fusarium disease, showing difference in the condition of the affected part, particularly in the appearance of the leaves.

PLATE II. Photographs of poured plate cultures twelve days old growing on nutrient agar (M4). Natural size. Fig 1, Culture of Fusarium oxysporum strain (H). The mycelium is depressed and slightly yellow in appearance. Fig 2, Culture of Fusarium (E) isolated from a diseased carnation. The concentric zone effect is due to the different degrees of density and height of the aerial growth. The mycelium corresponding to the inner light zone is purple (Saccardo Chromotoxia).

PLATE III. Photographs of poured plate cultures twelve days old growing on nutrient agar (M4). Natural size. Fig 1, Culture of Fusarium (R) isolated from a diseased carnation. The growth is cottony and has a very slight pink coloration in the central part of the plate. Fig 2, Culture of Fusarium (IV) isolated from a diseased carnation. The growth is cottony and has a slight yellowish tinge.

PLATE IV. Photographs of tube cultures twenty-three days of age. Tubes a, d, e, and f are growing on beet agar (M2). Tubes b and c are growing on nutrient agar (M4). Natural size. The tubes labeled (IV), (R3), (E3), and (E2) represent different strains of carnation Fusarium. The tube labeled (H) is a culture of F. oxysporum. All the strains from the carnation show a vigorous aerial growth and an abundance of color. The clearly defined pellicle at the surface of the slant is due to a deep wine-red coloration of the medium. This color shades into a lighter pink immediately above, but the central parts of the cultures have a sulphur yellow coloration and the upper portions remain white. The tube containing the F. oxysporum culture shows a depressed growth and a very pale salmon coloration in all parts except in the slight growth extending above the upper point of the slant; this is cottony and white.

PLATE V. Drawings to show various stages in the development of the Fusarium fungus.

Figures 1-8 represent various stages in the development of the carnation Fusarium. Figure 1, Macroconidia being cut off from a short lateral hypha. X1000. Figure 2, Macroconidia being cut off from a terminal hypha. X1000. Figure 3, Typical macroconidia developed in cultures on rice. Length 40 u., diameter 5 u.-7 u. X500. Figure 4, Typical macroconidia taken from a cluster of spores that developed on the stem of a diseased carnation in the field. Length 25 u.-60 u., diameter 4 u.-5 u. Their most common length is 35 u.-50 u. X500. Figure 5, A typical chlamydospore formed by the terminal swelling of a hypha. X1000. Figure 6, A germinating macroconidium forty-eight hours old. X500. Figure 7, A germinating macroconidium twenty-four hours old. X1000. Figure 8, A simple sporodochium showing the formation of spores. X500. Figures 9-11, Drawings to represent various stages in the development of the potato Fusarium. Figure 9, Microconidia being formed on a short lateral hypha. They vary in size from 5 u.-10 u. in length by 2.4 u.-3.4 u. in diameter. X1000. Figure 10, Typical macroconidia formed in a culture on potato; they vary from 15 u.-35 u. in length by 3.2 u.-5 u. in diameter. They are commonly 20 u.-30 u. in length. X1000. The constrictions at the septa are often conspicuous. Figure 11, a, Chlamydospore produced by a terminal swelling of a hypha. b, Chlamydospores produced by intercalary swellings of the hypha. c, A mature chlamydospore. X1000. The chlamydospores are usually 10 u.-12 u. in diameter.

The Botanic Garden of Oaxaca, Mexico*

By Prof. C. Conzatti, Director Oaxaca de Juarez, Mexico

Located on the grounds of the Agricultural Experiment Station, which was recently established in the State of Oaxaca, the Botanic Garden was started at the beginning of the year 1910. It did not, however, obtain official recognition until somewhat later, when the very moderate appropriation of $3,328.00 (Mexican) was granted by the government to defray the expenses of preparing the grounds, etc.

When I was appointed to organize and to manage the new Botanic Garden, my first step was to select, in perfect harmony with the direction of the Agricultural Experiment Station, the ground which seemed most appropriate. I chose the depression along the eastern side of the railway line, which runs through the station lands from north to south. This plot is of very good quality and is easy of access.

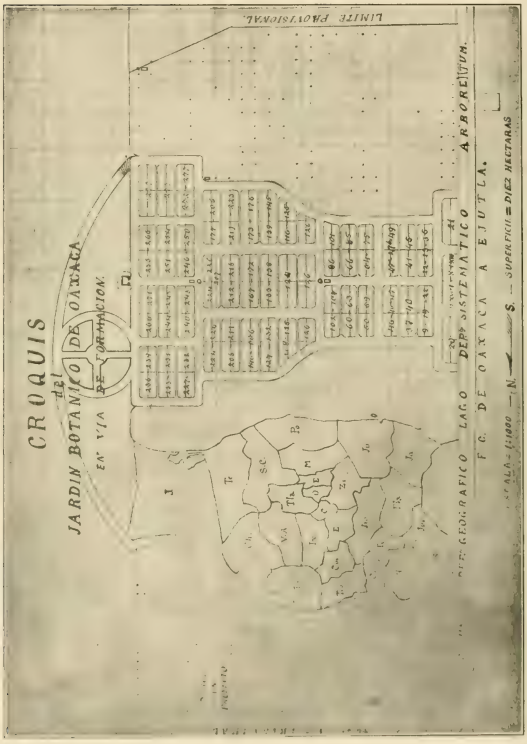
I must confess that the preliminary work of grading and putting the ground into proper condition was a remarkably difficult undertaking, the more so that during the first nine or ten months the only help I could have was seven or eight ordinary laborers (peones). For this reason, as well as for other troublesome circumstances, the garden is not yet in a position to furnish scientific material to the various educational institutions, or live plants to the public gardens of the near-by capital of the state, but I am sure that it will soon become able to do so.

The ground selected is in the shape of an almost perfect quadrangle, and covers an area of about 10 hectares (25 acres), there being the possibility of increasing this area, when needed, both on the eastern and on the southern side, but not on the two other sides, one of which is limited by the right-of-way of the Oaxaca-Ejutla Railway, and the other by the main avenue, which leads to the central building of the Agricultural Station.

This appears to be the second attempt in Mexico to launch an institution of this kind, which meets much favor in other countries, though it does not obtain much consideration in ours. The very first attempt was the establishment of a botanic garden at Guadalajara, which, since 1889, has had the good fortune of being promoted and protected by the illustrious Mexican scientist, Ign. D. Mariano Barcena, who was at that time the governor of the State of Jalisco.

It is certain, beyond all doubt, that the permanent establishment of a botanic garden in Mexico will be susceptible of a supremely ideal development, in view of the inexhaustible wealth of our national flora, the vast area of the republic, and the wide differentiation of climates characterizing it. That our central government must take positive and effectual interest

* Translation by Dr. F. Franceschi, Santa Barbara, Cal.


CROQUIS
DEL
JARDIN BOTANICO DE OAXACA
EN VIA DE FORMACION.
LIMITE PROVISIONAL
ARBOREUM.
DEPT. SISTEMATICO
LAG.O
F. G. DE OAXACA A EJUTLA.
ESCALA 1:1000 — N. — S. — SUPERFICIE = DIEZ HECTARAS

in the institution of botanic gardens is now made imperative by the incontestable progress of civilization in Mexico. In fact, all countries most advanced in civilization number their botanic gardens by the dozens. How does this happen? It must be acknowledged that the botanic garden is an institution of highly progressive and civilizing influence. If it were not so, the oldest leading civilized nations—Italy, France, England and Germany—would not devote so much care to them. Furthermore, not very deep thought is required to perceive that the botanic garden is the most efficient auxiliary of general agriculture on account of its great variety of cultures, and on account of the multiplicity of experiments which it makes possible. In the same way, no one will deny that the botanic garden will furnish the best means for the practical study of the biology of plants, with the priceless material for demonstration that it supplies. At the same time, without doubt, our botanic garden will become more and more a powerful incentive to the public to visit and take interest in the Agricultural Station. This will make more urgent the contemplated construction of about three kilometers of road between the capital of the state and the Agricultural Station.

The appropriation for the new institution being very limited, it was necessary for me to put aside all ideas of greatness, and of "showing off," to stick to the vital points, and to supplement, as far as possible, the insufficiency of labor with my personal and continuous superintendence, for the best advancement of the work.

I am proud to say that, from my point of view, nothing has been overlooked. The main object is to display, in a methodical manner, the greatest possible number of botanical species, preference being given to the native Mexican. The preparation of material for our educational institutions, and the laying of the foundation for a resort of instruction and recreation for the general public have also been taken into account.

With these objects in view it became necessary to divide the garden into different sections, as they are outlined in the sketch published herewith. The most prominent section is, of course, that of the systematic department, occupying the central part of the garden, and having the shape of a gigantic cup or bowl. This is subdivided into forty-five large squares of almost uniform area, on which the 277 families or orders of phanerogamous plants are distributed, according to the "Syllabus" of Engler, which, as I consider it the most perfect and modern classification of plants, I have adopted for the arrangement of the entire garden.

In each square, by setting plants two meters and a half apart, the number averages 48, thus making a total of 2,160 specimens for the whole section. It must be remarked, however, that from this section all annual and all arborescent species are intentionally excluded, and that it contains only perennial plants of small or of medium size. The reason of such exclusion is obvious. If regular trees were mixed together, their shade and their powerful system of roots would impair and even destroy the growth

of smaller plants. Annuals, on the other hand, after a short cycle of life, would disappear, and leave unpleasant vacancies in the beds.

In this systematic department, all plants are arranged strictly in accordance with their affinities, the three lower squares being occupied by vascular cryptogams, Cyperaceae, Graminaceae, Palmaceae and Cycadaceae. The six squares that follow comprise the balance of the monocotyledonous plants up to family 49. Dicotyledenous plants start with the fiftieth family, their subdivision Polypetalae taking 24 squares, up to family 226. The remaining 50 squares (family 227 to 277) are occupied by the subdivision Gamopetalae, which, according to the latest scientific views, are endowed with most perfect organization.

Including roads and paths between the beds, this department covers an area slightly inferior to two hectares (about five acres). Two wells have been dug along the central road, which runs from east to west, and supply all needs of irrigation. On the upper end of the systematic department, there is a miserable shanty which affords some protection to the laborers during stormy weather. All around this were sown seeds of various climbing plants, belonging mostly to the genera Maurandia, Tecoma, Bignonia, Distictis, Pithecoctenium, Gouania, and Passiflora.

Parallel to the main avenue of the station, on the northern side of the grounds, lies the fruticetum, the section which must receive the subarborescent flora of all countries, preference always being given to the native Mexican. Here the plan is to arrange, in a methodical order, species of shrubs or small trees, at a distance of five meters from each other. There are about 100 species planted already, the names of which I shall omit for the sake of brevity; and also because I hope to be able to issue, within a short time, a complete catalogue of all plants already in cultivation in this new botanic garden.

This fruticetum has an area of about one hectare and a half (3¾ acres), and will contain some 535 specimens, making a most interesting collection. At the northwestern corner, on rising ground, it is planned to build a small propagating house, as well as rooms for the herbarium and for a small reference library; also a place for tools and storage. Adjoining the above, a small conservatory will also be built for such plants as are essentially tropical, and for those which require a good deal of shade and moisture. The watering of this department will be easily provided by a pump, run by a small aermotor.

The arboretum occupies all the southern part of the garden, being particularly sheltered by a series of low hills which run from east to west. It covers an area of 3½ hectares (8¼ acres), upon which trees will be planted 7½ feet apart. Trees of all countries will be set here, preference being given to those of the American continent, and more especially to those which are natives of Mexico. The black dots on the adjoined plan mark the species already set out, which are distributed according to methodical

order of affinities, that is, from palms, conifers, etc., at the base up to Sapotaceae, Bignoniaceae, etc., at the top. About 700 species will find place here.

In a small enclosure of about 100 square meters, and well sheltered by groves of native shrubbery, the apiary of the Experiment Station was recently installed, quite appropriately, in view of the mutual interdependence of bees and flowers.

It remains for me to illustrate the geographical department, which reproduces in its main lines the political map of the State of Oaxaca. It is my most intense desire to make known as well and as completely as possible the vegetal wealth which is typical of our state. As far as botanic science is concerned, it is safe to say that the State of Oaxaca has been but scantily explored. When, to this circumstance, is added the wide expanse of its area, and the great variability of its climate, owing to its very high ranges of mountains, and deeply sunken valleys, with corresponding, widely diverging extremes of atmospheric pressure, this country cannot help being a particularly interesting botanical region. In this geographical department there are represented already the most prominent features of our native flora.

The extreme eastern side corresponds to the district of Juchitan, and offers a collection of 108 species of Cactaceae, mostly of the genus Opuntia, with representatives also of Cereus, Echinocactus, and Mammillaria, which are so plentiful in that region of the isthmus.

The extreme northwestern side, corresponding to the district of Huajuapan de Leon and of Silacayoapan, displays already a small collection of Agave, Beaucarnea, Hechtia and Yucca. This is sure to be much increased.

From the central districts the most characteristic conifers of our state, Abies religiosa, Pinus montezumae, Juniperus flaccida, etc., will be represented, the nucleus consisting of a fine specimen of Taxodium mucronatum, planted on July 1st, 1910, and raised from seed which I gathered myself on the colossal and historic "sabino" of Santa Maria del Tule.

From the southern coast districts of Tehuantepec, San Carlos, Pochutla, Juquila, and Jamiltepec, the most conspicuous palms and cycads of our state will be represented, nearly all belonging to the genera Acrocomia, Chamaedorea, Zamia, Dioon and Ceratozamia.

In this same department, room will be reserved for special groups of economic and of morphological interest, to be set out in due time.

I must not fail to mention the lake for the proper cultivation of aquatic plants, which will be supplied with running water from the Rio de San Antonio, by means of an electric pump.

The Culture of Citrus Fruits, Dates, and Other Crops in the Coachella, Imperial and Yuma Districts*

R. D. CORNELL

But few of the farms and orchards of the Coachella, Imperial, and Yuma districts have really been cared for in a scientific manner, have been made to produce all that could be expected of them under the most favorable management. Cultivation seems generally to have been neglected. The conditions of temperature and soil are such that by merely planting and watering the crop or orchard, it produces far in excess of most localities where much more careful attention is given to tillage and fertilization.

In the Coachella Valley, the soil is generally light, and care must be taken in the selection of land, that it is not too sandy and light for the best growing of crops. Alkali is general throughout the valley, and should always be avoided.

In the Imperial Valley the soils are divided into three types; soft, medium, and heavy. The soft soil is undoubtedly the best for orchard and farm work, as it consists of a light sandy loam, easily worked and handled. The heavy soil is of a stiff, clayey nature and will grow only a fraction of the crop that can be raised on the soft soil. It is very difficult to till, and causes constant trouble in cultivating after irrigation. The medium soil is a compromise between the other two in quality, ease of tillage, and productivity. Alkali and salt are found throughout the valley in varying quantities and should be avoided.

At Yuma are the mesa lands and the bottom lands. Here, both soils vary somewhat, the light soil being generally the best. On the river bottoms is to be found a silt loam, rich and medium soft. Salts and alkali vary from nothing up to one per cent.

CITRUS FRUITS

In no place visited in the three valleys was there any indication of scale or pest on the citrus trees. Gum disease, due to improper handling, was the only apparent ailment, and this had been overcome in most instances. The trees were all hardy and thrifty in appearance, and generally of good color. In no instance had the trees received proper care as to

*This article was written by Mr. Ralph D. Cornell, landscape gardener, as the report of an expedition to the districts mentioned. The expedition was made during the summer of 1912, under the direction of the Chuckawalla and Palo Verde Irrigation Association of Los Angeles, and the report is published here by the permission of Dr. George Wharton James.

irrigation, fertilization, tillage, and pruning, such as is given our orchards along the coast. It is thought by many that the absence of scale and spider is due to the extreme heat, and that citrus trees will ever be free from these pests in these localities. The same was said of the Riverside and Redlands districts, in their early history, when they were isolated from the scale-infested coast orchards, and grew clean without fumigation. Time has changed the view. Scale will live wherever orange trees live. The only thing that will keep it from our hot interior valleys is careful guarding and inspection by the Horticultural Commission, and co-operation on the part of those bringing trees into the country.

At Palm Springs are some 200 odd trees, varying in age up to eighteen years. It is said that trees, here, were twice cut back to the bare stump in order to save them at all, when the supply of irrigation water gave out. Today these trees are thrifty in appearance and produce three to four boxes of fruit from eighteen-year seedlings and Washington Navels, ripe and sweet for the Thanksgiving market, at a price of $3.50, f. o. b. Orange trees are here conceded to be shy bearers.

The grape fruit produced on the desert side of the mountains has a fine sweet flavor and a medicinal quality that is unequaled elsewhere in California. The grape fruits of this section vie with those of Florida. One five-year-old tree, at Palm Springs, growing in a yard with no cultivation, no pruning, and scant fertilization, produced three and one-half boxes of fruit for the Thanksgiving market, when prices were about $7 a box. No frost protection has been exercised in this locality, and there has been very slight frost damage.

At Indio, the advice is not to plant oranges, as the heat and winds cause the crop to fall. Also, the fruit produced is said to be dry and open-celled. All growers questioned, however, stated that oranges bade fair to become a profitable crop, but so much more profit is possible from date and fig culture that there is no object in bothering with citrus fruits. One rancher has 2,000 thrifty orange trees, that were grown and budded by him in the nursery rows, now ready to plant in orchard form.

Near Mecca are two orchards of note. One is a three-year-old, ten-acre grove that is too young to serve as a test, but has made a remarkable growth for three-year trees. The other comprises some sixty to seventy acres south of Mecca, that have been planted for six years. The story of these trees is as follows: The trees were planted when two years from the bud, and set with the bud two to four inches below the surface of the ground. This caused gum disease that was later cured by uncovering the crown, and by proper care in watering. After having been tended for a year, one orchard was practically abandoned for fear of inundation from the Salton Sea. Only one Indian was left to care for the whole place. At the end of the second year it changed hands, and was given water and cultivation for two years. Then the surface roots were all uncovered and chopped off,

through some mistaken idea that this operation would help the trees by causing them to take deeper root. Thus, the feeders were largely destroyed. The following year, when the trees were five years old, the orchard produced its first carload of fruit, which topped the New York market by 85c per box above any other California fruit, and 75c above any Arizona fruit. When six years old, the trees produced five carloads of fruit that sold for $2.66 a box on the trees. This orchard is about 185 feet below the sea level, planted on a loose, sandy loam, with apparent traces of salt and alkali. It now receives fortnightly irrigation in the summer, with double cultivation after each irrigation. It has had some fertilizer and pruning. The trees are thrifty in appearance, of good size, and have set a fair crop of fruit this season. Pomeloes in the same orchard are producing good crops of excellent fruits.

In the Imperial Valley are oranges, lemons, tangerines, and pomeloes, though very little has been done in the way of orchard planting. The Washington Navels, Valencias, Mediterranean Sweets, and tangerines have generally proved to be shy bearers, though the early season, high coloring, and superior quality rather offset this character. One horticulturist at Brawley thinks that the Navalencia is the coming orange for that locality, as it produces three times the crop that the navel does, and is of excellent flavor. Lemons thrive, if in a frostless locality, but produce only one crop a year. Near El Centro one Villa Franca lemon tree, five years old, produced, in one crop, over seven boxes of fruit that sold for over $30. The grape fruit seems to be more productive than other citrus fruits. There are several young orchards started in the valley, and high hopes for the future of the industry are entertained by many of the ranchers.

At Yuma are fifty-five acres of eighteen-year-old citrus trees. Here Washington Navels, Mediterranean Sweets, Valencias, and pomeloes have been planted. The trees were set too deeply when planted, the buds being put some 2-3 feet below the surface, and they have since had irregular and unskilled care. They have had some fertilizer and water, but poor cultivation and pruning. At present a cover crop of weeds and grass is thriving, as it is thought that this keeps the ground cool, and protects the roots from the hot summer sun. In the winter cultivation is practiced. Here, as elsewhere, salt and alkali can be traced in the soil. Of these trees the Mediterranean Sweets, Valencias, and pomeloes are fairly prolific, but the navels are shy bearers. Accurate reports on the number of boxes produced were unobtainable. The fruits all ripen for the Thanksgiving market, and have never been injured by frost, with the exception of leaf damage to some lemons in the winter of 1911-1912. The trees are thrifty, clean, and of good color.

In general, citrus trees show remarkable possibilities and seem well adapted to these localities, provided that proper selection of soil is made where there is no frost damage, and that wisdom is shown in the planting and subsequent care. Little scientific work has been done as yet; no frost

protection has been given; the matter of soil humus has been absolutely ignored. By proper experimentation, varieties might be found that would bear prolifically. The industry is in an embryonic stage, but has developed to that point where fairly accurate conclusions may be drawn as to its future. Modern methods of culture, with the choice of the interior situations, should make a combination hard to beat.

DATES*

About 7,000 date off-shoots have been imported into the United States since the beginning of the date industry. Dr. Coit says that all of the requisite conditions for the successful growing of dates may be found in many places throughout the Imperial, Coachella, and Colorado Valleys, and the country around Palo Verde and Blythe, Riverside County. The Imperial, Coachella, and Colorado Valleys, are the regions in which date culture has proved its worth, and where are now to be found bearing orchards and thousands of newly-planted off-shoots. Dates are so far subject to pests, only as imported on the young plants and subsequently scattered. This infestation is in the form of scale of two distinct varieties—the Marlatt and Parlatoria. A spray has been found that will kill these scales, thus eliminating all future danger from outside infection and making possible its eradication. Spraying and burning with a gasoline torch have proved to be effective means of destroying scale on old and established palms.

The date is not particular as to the soil in which it grows, and will thrive in considerable alkali. Light and heavy soil alike seem to produce dates. While the date is a desert palm and requires a long period of intense heat for proper development and ripening, the roots require an abundance of water. Dr. Coit says that one miner's inch of continual flow is sufficient to maintain a five-acre orchard of bearing dates.

The off-shoots are set 25 feet by 30 feet apart, or about 60 trees to the acre, and begin to bear at the ages of from three to five years. Seedlings are somewhat uncertain, but off-shoots always come true to the parent. A conservative estimate of the bearing capacity of a ten-year-old tree would be 100 pounds. Some will bear as high as 400 pounds to the tree. A leading Los Angeles grocer has placed the retail price for fresh California dates at from 50c to 75c a pound. They bring from 15c to as much as $1 a pound to the grower. Fruit matures here from September through December, some varieties ripening on the trees, others requiring artificial heat. The Deglet Noor is very popular among growers at present, as it will ripen on the tree before the cold weather comes, and is of unusual delicacy of flavor.

A palm reaches its maximum bearing capacity at ten years and will continue to produce for one hundred. One palm sometimes bears as high as

*The portion of this article which treats of the date has already been published with other articles on the same subject and with many illustrations, by Out West, of Los Angeles, and may be purchased at half price by subscribers to this Journal.

twenty bunches in a season. Off-shoots are produced between the ages of three and fifteen years, after which no more appear. During this period, one palm will produce ten or twelve off-shoots, sometimes more. The importer's price for off-shoots is $8 apiece; those grown locally cannot be had for that.

Palm Springs can boast of a few young date palms that have come into bearing, but has nothing on a commercial scale, nor any palms of great age.

At Indio is located one of the government experimental stations, where date culture is being forwarded. On an adjacent ranch are four Deglet Noor trees that produced 300 pounds last year that sold for $1 per pound on the average. Twelve imported trees on the same ranch will produce this season, at the age of seven years, about 750 pounds of fruit, as they are now laden with 75 bunches of dates. An offer of $25 apiece for off-shoots from these Deglet Noor trees was refused, as the owner wished to set more plants, and considered them worth that much to himself.

At Mecca is the largest experimental date garden in the valley. These trees are growing on soil containing three-tenths of one per cent alkali and have been fertilized regularly each year, with one yard of manure to a tree; and have received frequent and abundant irrigation, with prompt cultivation after each watering. The trees have been sprayed for scale. All of the old palms are heavily laden with fruit and are in splendid condition.

Situated a few miles southwest of Mecca is an orchard containing 5,000 date palms. Of these between 300 and 400 are of bearing age, running from three to five years. The crop on them is estimated at 2,000 pounds, and should average 75c a pound. From one three-year-old Deglet Noor tree the owner took 90 pounds of fruit. When four years old, this tree produced no fruit. This season, at the age of five, the crop is estimated at 250 pounds, of which 150 pounds are engaged at $1.50 a pound. In addition, the palm has already produced three off-shoots. This grower expects to net from $300 to $600 an acre from his dates when they have become ten years of age. These trees are growing in soil that contains from one to six-tenths per cent of alkali, and some salt. They are fertilized with manure once a year, and trees producing fruit are fertilized with potash, phosphates, and cotton seed. Several other ranches in this vicinity have trees producing excellent fruit.

The Imperial Valley is sprinkled with date plantings and has several experimental farms where dates are grown. The trees thrive and fruit here very readily, as the date is well adapted to such climatic conditions as exist here.

One of the Arizona experimental farms is situated at Yuma, where seven-year-old dates may be seen in full bearing. These trees have never been fertilized. Cultivated crops have been grown between the rows, through

which the dates have received their only tillage. In the spring of 1912, the palms were pruned severely and burned with a gasoline torch, to kill the scale. After this harsh treatment, one seven-year-old palm, that already had eight off-shoots, produced ten bunches of fruit. Some palms did not bear at all.

Thrifty fruiting palms are also to be found on the mesa near Yuma. These have had little care but the water necessary to keep them growing. One nine-year palm produced, in 1911, 210 pounds of fruit that sold for 10c per pound, f. o. b. Yuma.

The date industry seems to be a coming thing for these valleys, and while the results so far obtained are largely problematic, there seems to be no reason why the future shall not witness great commercial success of date culture. The seedlings are uncertain as to sex, quality of fruit and age of bearing, but by proper selection and propagation from off-shoots, standard varieties can soon be produced in abundance. Scale is under control, and the climatic conditions are proved. Time will do the rest.

FIGS

One grower has had black figs on the market by the first week in May, and was the only shipper on the market in America, for three weeks. He has also shipped figs for the month preceding Christmas. He sold his first box, in May, for $2.00 a pound. The next went at $7 a box. Then prices gradually dropped to $5, $4, and $3, one box going for $2.50. The second crop ranged from $2 to 50c a box. The last crop is profitable at 50c a box, but cannot be made to pay at less. The express and commission charges on a 50c box are 12c, after the fruit has been grown, picked, packed, and delivered to the station. In this especial locality, cuttings planted in the open ground, have been known to produce figs within eighteen months from the time of planting.

Figs do equally as well lower in the Coachella Valley, although especially favored localities, such as the above-mentioned, produce fruit slightly earlier than others. Around Mecca are to be found many figs, bearing abundantly and growing on soils of varying composition.

In the Imperial the crop is generally two to four weeks later, although the quality is equally as good. One grower shipped black figs during the first week in June. Another claims to have produced Smyrnas in May, by the aid of the wasp from the new capri, and says that three crops a year will thus be possible.

The Yuma figs ripen about the same time as those in the Coachella, and are equally as productive and sweet.

The fig seems second only to the date as a commercial fruit for these warm valleys, and produces fruit of such quality and at such an early season that it has no outside competition. Refrigeration of fresh figs, for

eastern markets, is as feasible here as at Fresno, and could be carried on much earlier in the season.

GRAPES

Grape culture is one of the first experiments in the reclamation of hot and arid lands. Here it has been exploited to quite an extent and has netted big returns in many instances, although as yet there seems to be considerable difference of opinion as to the best varieties. The Malaga has been planted more than any other grape and is being shipped in refrigerated cars to the eastern markets, both from the Coachella and Imperial Valleys.

At Palm Springs, Malagas have been injured by rain coming at the time of ripening, but growers in the valley stated that they had not been troubled in this way.

An Indio grower who raises fancy table grapes says that only early grapes are suited to that locality, as fruit that is not ripened by the time the thermometer reaches 115 degrees is scalded by the sun. Here Blue Portuguese ripen the first week in June, and Thompson Seedless on the first week of July. In 1911, three-quarters of an acre produced $375 worth of fruit that averaged $1.60 a crate. Another shipper sold his first grapes for $3.25 a box, in 1911, with a high market throughout the season. In 1912 the first fruit brought $4, but the price slumped and dwindled immediately to $1.25.

A rancher near Thermal netted $200 an acre on Malagas, at an average price of $2.50 a crate gross, some going as high as $5.15. He marketed his crop the first week of July, at a cost of $30 an acre, delivered to the packers. The third year from planting, the crop more than paid for all upkeep. In 1906 another planter set 8 acres of heavy land and 16 acres of sandy land to Malagas. The heavy land has never produced a grape of quality. When 3½ years old, the 16 acres on sandy soil produced $1600 worth of fruit; when 4½ years old, they brought $3165; when 5½ years old, $5720. Another 30 acres of Malagas 5½ years old netted above every expense, including salary of caretaker, $9600. A vineyard, 2½ years old, brought, including picking and hauling, $700 from 2½ acres. When 3½ years old, it brought $1100.

In the Imperial Valley, Malagas are a paying crop, at present, but the prospects for the future are that Persian grapes will be the more profitable, as they ripen a week to two weeks earlier.

MISCELLANEOUS FRUIT TREES

Apricots are profitable, generally, though not so commonly planted as the fruits previously mentioned. Near Indio, the Newcastle ripens during the first week in May, the Royal on the last week. From two Newcastles and one Royal, 7 years old, were picked, in the spring of 1912, 660 pounds of fruit. The Newcastles brought $3 a crate of 20 pounds; the Royals,

$1.50. From one 6-year-old tree, in 1911, was sold $23 worth of fruit. In the Imperial, "cots" ripen during the month of May, and bring very good prices. One orchard of Blenheim "cots," near El Centro, which has had excellent care, bore 100 pounds to each 5-year-old tree. These "cots" ripened on the first of June, and sold for from 3c to 10c a pound to the canners, as they are too late a variety to command a good price on the fresh markets. They bore some fruit at three years, but were not self-supporting until the fifth year, although crops of milo maize and cotton, raised between the rows, paid an income. It cost 35c a crate of 20 pounds to prepare the fruit for the market, besides growing and hauling.

Plums, peaches, nectarines, cherries, apples, almonds, and pears have all been tried with varying success. The almond does splendidly in locations that are frostless. Otherwise it is unsuccessful. One 7-year tree of the paper shell variety, near Indio, produced 65 pounds of shelled nuts that brought from 15c to 25c a pound. The Wickson plum and some varieties of peaches seem to thrive, but it remains for the horticulturist to solve the problem of varieties. The Winter Bartlett pear has proved itself well adapted to the arid climatic conditions. It begins to bear at the age of three years, and is self-sustaining at five. The fruits ripen in the latter half of December and will average 20 pounds to a 5-year-old tree. The market price averages 10c a pound. The pomegranate is very prolific, producing a large fruit of excellent quality. Wherever tried, the olive has borne prolific crops of large-sized fruit such as highly recommend its culture as one of the future industries. The trees are of rapid growth and absolutely clean. The pistachio nut and jujube have borne fruit on specimen plants, and may some day be developed into something of worth.

TRUCK GARDENS

Probably in no place in California are vegetable garden crops produced earlier than in the Coachella Valley. The light soil, mild winters, abundance of heat, and plentiful irrigation seem to be the reasons for their almost phenomenal growth. Truck gardening has proved profitable where the owner was willing to get into the field and do the work himself, and was content to plant only what he himself could care for. On a large scale there is a much greater risk, as such crops require prompt attention and thorough care. One grower cleared $1200 on an acre of tomatoes, and was so encouraged that he attempted a much bigger planting the following year, with the result that he could not handle so much, and lost the whole. Beans, squashes, cucumbers, onions, asparagus, melons, cantaloupes, peppers, peanuts and sweet potatoes have all proved themselves profitable crops in these valleys, when rightly handled.

One property owner near Thermal cleared, above every expense, including 7 per cent on $250 per acre, $3000 on 9½ acres of onions. On this land he raised a second crop of nine bales of cotton. On 10 acres of 2-year-

old asparagus he netted $600. In all, he made 40 acres of productive land carry 15 acres of unproductive grapes and net $4600, after hiring all labor, including a manager.

Four and forty-three hundredths acres of Yellow Bermudas produced 1500 crates of No. 1 onions that netted 63c a crate of 50 pounds. They brought from 90c to $2 gross, averaging $1.13 per crate.

Cantaloupes will produce 350 crates to the acre. Fifteen tons of watermelons are considered a good crop.

An acre of asparagus in Imperial Valley netted $150 on the January and February markets. Eighty-six hundredths of an acre, at Yuma, three-fourths of which were yearling plants, the rest being 2-year-olds, produced for the May market $200 worth of shoots at an average price of 10c a pound.

In the Imperial are 10,000 acres of cotton this summer. The crop brings from 8c to 15c a pound. At Coachella, cotton was not picked because the market price was only 8c. Short staple cotton is grown mostly now, but the opinion is that the long staple is the coming crop for the valley.

FUNDAMENTAL AGRICULTURE

After all is said and done, it remains a fact that here, feed is the basis of agriculture. One resident has truly said, "Alfalfa will make the homes." Without it all else would be impossible. Alfalfa is cut from five to eight times a year, and produces from five to twelve tons per acre, per annum. By proper management, it should be made to produce, regularly, ten tons to the acre. This is the most staple crop of the valley.

Kaffir corn and milo maize are both grown for their seed, the latter producing somewhat the greater tonnage. Milo maize will sometimes make two crops to the season, producing from one to two tons of seed to the acre, each crop. This seed sells at about $20 a ton and is used for poultry and stock food. Indian corn is grown some, but does not produce as well as the Egyptian corn.

The fattening of cattle and hogs, in alfalfa pastures, and the dairy and poultry industries, are all profitable, and are sure to grow with the country and become basic factors in the wealth of the community.

Alfalfa and stock fattening are the foundation upon which the homes are to be built. Next in importance comes the culture of dates, perhaps the best of the horticultural possibilities. After dates, figs will be given recognition, then citrus culture, and so on down the list of fruits, vegetables, and grains. The horticultural possibilities of these desert lands have been, as yet, only partially explored. What may lie beyond is at present merely a dream of the idealist, but a dream which modern scientific methods will cause to come true.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II DECEMBER 1912 Number 4

The Palms Indigenous to Cuba II*

ODOARDO BECCARI
FLORENCE, ITALY

EUTERPE Gaertn.

Gaertn. Fruct. et Sem. I. p. 24 (excl. cit Rumphii) t. IX f. 3 (**E. globosa**) Mart. Hist. nat. Palm. II, p. 28. **Catis** Cook in Bull. Torrey Bot. Club, 1901, p. 556. **Acrista** Cook l. c. 1901, p. 555, and 1904, p. 353. **Prestoea** Hook f. in Benth. et Hook. Gen. pl. III, p. 899 (partim?).

The generic name *Euterpe* was first proposed by Gaertner (De fructibus et seminum, Vol. I 1878, p. 24) for two palms, *E. globosa* and *E. pisifera*, evidently not congeneric, according to our modern views. Of these the fruits were figured in Plate IX. Later, in Vol. II (1791), Plate CXXXIX, was figured the fruit of the *E. pisifera*, which is in fact a palm quite different from the other two; nevertheless *E. globosa* must be considered as the type of the Genus *Euterpe* as being the first so named.

Martius (Hist. nat. Palm. II, p. 28) made use of the generic name *Euterpe* for another palm (*E. oleracea*) which had a fruit so similar to that figured by Gaertner for *E. globosa* that he, evidently suspecting the identity of his plant with that of Gaertner, added, doubtfully, however, to his own diagnosis, the synonym of *E. globosa*.

Bentham and Hooker (Genera plantarum, III, p. 896) have apparently considered as the type of the Genus *Euterpe* the second species figured by Gaertner, the *E. pisifera;* but in this I recognize now, with scarcely a shade of doubt, the *Heterospatha elata* Scheff., a palm common in the Moluccas and the Philippines, and in the *E. pisifera* B. the *Dictyosperma rubra,* of which Gaertner received the fruits from Hermann, who also sent him those of *Hyophorbe indica,* another palm inhabiting the same region with *Dictyosperma rubra.*

Blume, Miquel, and Martius, in considering *E. globosa* Gaertner as corresponding to *Calyptrocalyx spicata*, had regard only to the quotation of Rumph: *Pinanga silvestris globosa* (Herb. amb. I. p. 38, t. 5 f. 1 A), not to the figure of the fruit given in Gaertner's Plate IX.† Mr. Cook, however, holds this identification to be certain and says that "The name *Euterpe* has no true place in American botany, having been proposed originally for an unrelated East Indian palm." Accordingly, he calls the American *Euterpes, Catis,* and con-

*The first part of this monograph appeared in this Journal in May, 1912.

†Martius l. c. on this regard writes: *Euterpe globosa* Gaertn. Fruct. I p. 24, quoad Rumphii citatum, nec vero quoad fructum descriptum et t. g. illustratum.

siders the *Euterpe oleracea* as the type of the Genus, and makes of it a *Catis martiana*.

For my part I maintain that Martius has correctly referred his *E. oleracea* to the Genus *Euterpe* of Gaertner, but I consider that species to be specifically distinct from *E. globosa* Gaertner. Moreover, I think it quite certain that Gaertner's *Euterpe globosa* corresponds to the species of this genus very widely distributed in the Greater and Lesser Antilles, and known under several other more recent names. The only character in Gaertner's description apparently not corresponding to this identification is the "bacca cum brevi acumine", but it is precisely this circumstance that supports me in the belief that the said Plate IX, f. 3, represents the *Euterpe* so common in the Antilles and not another of the more diffuse Brazilian species, because these have the remains of the stigmas very plainly apparent on one side of the fruit; whereas in the Antillean *Euterpe*, when the fruit is deprived of the perianth (as in the fruit represented by Gaertner) these remains may appear just like a small apical acumen.

To *Euterpe globosa*, I think, also, referable the *Acrista monticola* O. F. Cook, as I have not been able to discover any diagnostic character by which it may be distinguished from the common *Euterpe*, so largely diffused in all the Antilles. In conclusion, according to my views, the genus *Euterpe* remains as understood by Martius, Scheffer, Bentham et Hooker, Drude, Barbosa-Rodrigues, etc., *Catis* and *Acrista* being synonyms.

I have, however, to observe that the genus *Euterpe* is not perfectly homogeneous, as some of the species described under this name have fruits with ruminate albumen, while the fruits of others have homogeneous albumen. The true *Euterpes* must be considered those which, like the type (*E. globosa*), have a seed with a ruminate albumen. *E. oleracea* Mart. (H. n. Pal. t. 29, 30) and *E. acuminata* (Willd.) Wendl. belong, also, to this group. Among those known to me, *E. edulis* Mart. (l. c. t. 32), *E. praecatoria* Mart. and *E. catinga* Wall. have a non-ruminate seed, and for these I propose the name *Euterpopsis* as a subgenus. I have not, however, discovered in the flowers of the species of the two groups any correlative characters by the help of which, when the fruits are not available, it may be decided to which of the two groups a given species belongs. Barbosa-Rodrigues (Contr. Jard. Bot. Rio de Jan. 1 (1901), p. 11, and Sertum Palm. p. 37) has divided the genus *Euterpe* into two sections: those with simply bilobed primordial leaves, and those having these leaves radiately divided. This certainly is not a very practical division for herbarium work, but I would observe that *E. oleracea* and *E. globosa*, which have a ruminate seed (true *Euterpe*) certainly produce a bilobed primordial leaf; while *E. praecatoria* and *E. catinga* (*Euterpopsis*), which have homogeneously albuminate seed, have, according to Barbosa-Rodrigues, radiately sect primordial leaves.* There is, therefore, apparently a correlation between the nature of

*I must warn the reader that in the "Sertum Palmarum" by Barbosa-Rodrigues and in his Contr. l. c. I, *E. edulis* corresponds to *E. oleracea* Mart., and vice versa *E. oleracea* to *E. edulis* Mart. as the author himself acknowledges in Contr. IV, 115.

the seeds and the form of the primordial leaves. But there are yet several species of which the fruit is unknown, and probably it will be a long time before the nature of the primordial leaves of all of these is ascertained.

Euterpe globosa Gaertn. Fruct. et Sem. t. 24 (excl. syn. Rumphii) t. IX. **E. brevivaginata** Mart. Hist. nat. Palm. III, p. 309. **E. montana** Graham in Bot. Mag. t. 3874.† **E. manaele** Gris. et Wendl. ex Gris. Pl. Wright. 530 n. 1468, et Cat. pl. p. 222. **E. oleracea** (non Mart.) Gris. Fl. Brit. W. Ind. 517. **Acrista monticola** O. F. Cook in Bull. Torrey Bot. Club, XXVIII (1901), p. 557, t. 46; Urban, Symb. ant. IV, p. 129. **Prestoea montana** Nichol. Dict. III (1886), p. 216 (ex Ind. Kew); Nich. et Mottet, Dict. d'Hort. (1895-96), IV, p. 319. **Oreodoxa manaele** Mart. Hist. nat. Palm, III, p. 310.

I consider as belonging to the typical *E. globosa of* Gaertner the specimens collected by Wright in the East of Cuba (n. 1468) and distributed under the name of *E. manaele* Gris. et H. Wendl. I have seen a specimen of these in the Herbarium de Candolle, consisting of only two leaflets and of one branchlet of the spadix with quite ripe fruits. The *leaflets* are apparently taken from about the middle of an adult leaf (which was certainly a large one), are broadly ensiform or very elongate-lanceolate, of a firm papery or thinly coriaceous texture, 90 cm. long, 6-6.5 cm. wide, obliquely inserted on the rachis by a rather narrow base, the margins there being strongly reduplicate; they narrow gradually upwards from about the middle, then taper rather suddenly to a slight asymmetrical apex, are green on upper surface and slightly paler underneath; the mid-costa is robust, considerably prominent and acute on both surfaces and is interruptedly covered on the lower by appressed brown scales; on each side of the mid-costa are 4-5 unequal and more or less distinct secondary nerves; of these one or two, also on each side, are often stronger than the others, so as to render the leaflets sub-3-5-costulate, especially in their terminal portions; the tertiary nerves are not very numerous and not very sharp; the margins are considerably thickened; the transverse veinlets are barely visible or quite obsolete.

The branchlet of the *spadix* is 45 cm. long, and apparently furnished with a basal axillary callus; it has the glomeruli of flowers disposed all round in 4-5 longitudinal series; it is 6 mm. in diameter in its lower part, and gradually narrows above; is rigid, terete, glabrous, reddish brown, finely wrinkled, very slightly sinuous between the glomerules, and bears the flowers superficially, and not inserted in pits or scrobiculi.

The *flowers* appear, from the scars left after their fall, to be three-nate (the central flowers being female and the side ones males) in the lower part; they are geminate above but only male. The pulvinuli or scrs left by the fallen female flowers (or fruits) are quite superficial and flat, oblong and surrounded by the usual bracteoles, which are small and form a very narrow membranous ring around the scars; the lower general bract is small, also membranous, rounded and very similar to the floral bracteoles; the scars of

†Plate 7797 of the "Botanical Magazine" is possibly a representation of this species; in this it bears the name of *Exorrhiza Wendlandiana* Becc.

the two male flowers are situated at the sides above those of the female, and are not prominent.

The ripe *fruit* is exactly spherical, 12-13 mm. in diameter when dry, and has the remains of the stigmas placed, in the form of a small three-lobed tubercle, in about the middle of one of the sides, and may be easily overlooked. The pericarp is on the whole, very little over a millimeter thick; the epicarp is pellicular and in the dry condition is rendered minutely and rather obsoletely granulose by small punctiform, or very shortly linear sclerosomes; under the epicarp is found a very thin layer of fleshy tissue, then another layer grumose or granulose, and within this lie several flattened fibres, which form a kind of sac, covering the entire seed; they are coarse and interlacing, or net-like anastomising, on the upper part of the seed, and remain independent, parallel and disposed in 2-3 layers in the remainder; in time, when the pericarp falls into decay the fine and very acuminate ends of these fibres form a kind of brush at the base of the fruit. Some of the innermost fibres of the mesocarp are very thin, flattened, almost hyaline, and remain adherent to the surface of the seed, or more correctly to the endocarp, which is extremely thin and connected with the testa of the seed all over the surface of this, except at the base, in proximity to the hilum, where it forms a kind of papyraceous, straw-colored, non-adherent, suborbicular, thin shield, 5-6 mm. in diameter.

The *seed* is globular, 11 mm. in diameter, has a dull hazel brown surface, upon which there usually remain adherent and slightly impressed some of the inner, soft, whitish, very thin fibres of the mesocarp; the vascular branching of the raphe forms a complete network all around, but this is very superficial and not very apparent; the hilum is linear and extends over to about the fifth part of the circumference of seed; the albumen is deeply irregularly radiately ruminate, and has an irregular fissure in its center; the embryo is exactly basilar, and penetrates the third part of the mass of the seed; its position is recognizable externally by a small depression, which is covered by the shield-like portion of the endocarp. The fruiting perianth is rather shallowly cupular, 7 mm. in diameter; the sepals and petals are rigid, dry in texture, reddish brown; the sepals are reniform, callous and gibbous at their bases; the petals are twice as long as the sepals, broader than high, very obtusely apiculate, nitent inside, finely striately veined externally. (Figure 144.)

E. globosa is a fine tree with a smooth cylindrical trunk, attaining the height of 10-15 m., perhaps more, from 12-15 cm. in diameter, and distinctly ringed by the leaf-scars. The leaves are large and very regularly pinnate. It seems a rather variable plant with regard to some of its vegetative features, having the leaves of a more or less rigid texture, and varying, also, exceedingly as to the development of the branches of the spadix, these being sometimes short and rigid, at other times elongate, flaccid and sinuous. I have, however, found the most perfect identity of the flowers and fruits in all the numerous specimens I have examined, which come from almost every island of the Antilles, from Cuba to Grenada, the most southern of the Lesser Antilles. It is true that the specimens coming from this last island, to which properly the

name of *E. montana* is due, have stout spadices with short thickish rigid branchlets; but this same aspect of spadices is shown in specimens from Martinique (Hahn n. 805); while other specimens from this same island (Hahn n. 580) have spadices in no way distinguishable from those of the plants from Porto Rico, Cuba, etc. The more or less stoutness and rigidity of the spadix and of the leaves is no doubt a phenomenon depending upon the different conditions of ambient, in which the plants lived, from which the specimens were gathered.

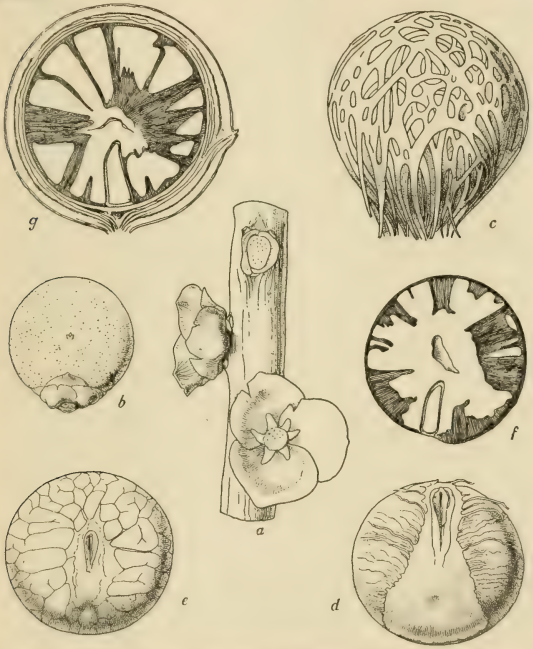


Figure 144. Euterpe globosa. a, portion of a branchlet with two fruiting perianths; b, fruit, front view; c, seed covered by the sac formed by the inner layer of fibres of the mesocarp; d, seed covered by the partial shield-like endocarp; e, same seed after it had had its surface polished to show the branching of the raphe, as seen from the side of the hilum; f, the same seed cut longitudinally through the embryo; g, longitudinal section of an entire fruit after it had recovered its fresh appearance by boiling; this last figure from fruits collected in Porto Rico; all the other figures from Wright No. 1468.

Of *E. oleracea* I have seen specimens from the following localities: Cuba—*Wright* n. 1468 (Herb. de Cand.). S. Domingo—*Pater Miguel Fuertes* n. 562; *Eggers* n. 1601, 1848 "Sierra de Palo Quemada"; *H. Von Tuerckheim*, prope Barahona (Herb. Berol.). Porto Rico—*Sintenis* n. 483, 2118, 1525, 1468 (Herb. Berol.); *Bertero* (Herb. de Cand. et Berol.); *Eggers* n. 1165, 1170. Saba (Dan. Ant.)—*Suringar*. 23, IV, 1885 (Herb. Berol.). Tobago (Dan. Ant.)—*Eggers* n. 5740. Martinique—*Hahn* n. 580 and n. 805 (Herb. de Cand.); *Perc Duss* (Herb. Berol.). Guadeloupe—*Duchassaing* (Herb. Berol.); *Perc Duss* n. 3800. St. Vincent—*Eggers* n. 6756 (Herb. Berol.). St. Kitts (St. Christopher)—*Britton* and *Cowell* n. 306 (Herb. Berol.). Grenada—*Eggers* n. 6173 (Herb. Berol.); *R. V. Herring*, 15, V, 1891 (Herb. Berol.); *W. E. Broadway* n. 1460 (Herb. Berol.).

I have seen no specimens from Jamaica.

Gardiner in Proceed. Ac. Phil. (1890) p. 359 (non vidi) mentions a *Euterpe oleracea* from the Bahamas, which also should probably be reduced to *E. globosa*.

CALYPTROGYNE H. Wendl.

H. Wendl. in Bot. Zeit. 1859, *72*; Benth. et Hook. Gen. plant III, 914; **Calyptronoma** Griseb. Fl. Brit. W. Ind. 518; **Geonoma** Auct. plur.

Calyptrogyne swartzii Becc. **C. dulcis** G. Maza in Dicc. Botan. (1889), *72*, and Nociones de Bot. (1893), 50. **C. occidentalis** G. Maza, Noc. l. c. **C. intermedia** G. Maza, Noc. l. c. **Calyptronoma swartzii** Griseb. Fl. Brit. W. Ind., 518. **Geonoma (Calyptronoma) swartzii** Gris., Wright n. 1466; Gris. Cat. pl. Cub., *222*. **Geonoma (Calyptronoma) dulcis** Wr., in Gris. Cat. pl. Cub., *220*. **Geonoma swartzii** Gris. et Wendl. (Wr. 1466); Sauvalle, Fl. Cub., 153. **G. intermedia** Gris. et Wendl. (Wr. 3972); Sauv. l. c. **G. dulcis** Wr., Sauv l. c. **G. plumeriana** Mart. Palm. Orb. 34, et Hist. nat. Palm. III, 316. **Elaeis? occidentalis** Sw. Fl. Ind. occ. I, 619.

In the photograph reproduced in Fig. 145, *Calyptrogyne swartzii* appears as a palm of medium size, but with relatively stout stem, 20-25 cm. in diameter, somewhat crooked, and rendered rough by very prominent ring-like leaf-scars. According to Grisebach the trunk is 5-8 m. high, and is only slightly enlarged at its base (trunco 15'-25' alto basi subæquali—Gris.)

Leaves 5-6 m. long (Gris.), very regularly pinnate; leaf-sheaths short, with a thick broad base, which gradually narrows into a short robust petiole; rachis glabrous, or minutely dotted with inconspicuous scales. The leaflets are numerous, closely and very regularly set in one plane, narrow and long, or ensiform, very gradually acuminate from below the middle to a long, slightly falcate, and slender point; are strongly reduplicate at the base, and with the margins almost involute, firmly papyraceous or thinly coriaceous and distinctly 5-8-costulate; the side costæ appearing considerably prominent underneath, and slightly above; the lower surface moreover has the mid-costa furnished with linear, brown, chaffy scales, and has the tertiary nerves covered with extremely minute punctiform scales; otherwise it is of about the same

Figure 145. Calyptrogyne swartzii.

color as the upper; margins sharp; transverse veinlets quite obliterate. The middle leaflets of larger leaves are 60-80 cm. long and 3-4.5 cm. broad, but at times they are considerably smaller, shorter and narrower; the upper and lower leaflets are always shorter and narrower than those of the middle.

The *spadices* are glabrous in every part, interfrondal, and several, of different degrees of development, are present at the same time on the same tree; they are strongly recurved and make their way from among the bases of the leaves; they form a dense, oblong, pendulous, twice-branched panicle, 40-50 cm. long, borne on a rather robust peduncular part, about as long. The spathes are double, the outer sheathes the peduncular part of the spadix and the base of the inner spathe; this is about 50 cm. long, 8-9 cm. broad, thinly but firmly coriaceous, concave-cymbiform, lanceolate in outline, tapering above to a dorsally keeled acuminate apex; it is mahogany red, striate and almost glossy inside, dull, reddish brown, when dry, and very thinly and sparingly furfuraceous externally; the main branches are thick and short, spirally arranged all around the axis and approximate one to the other; each primary branch is suffulted by a broadly triangular acuminate bract, and very soon divided into 2-4 flower-bearing branchlets; these are 15-25 cm. long, subterete, thick, of the uniform diameter of 5-8 mm. and only taper a little above to an acute tip; they are deeply, very regularly and closely scrobiculate or alveolate along 5-7 longitudinal series; the alveoles are polished inside and have the form of an ogival niche, 8-12 mm. apart in each series, and have, at the base, a very conspicuously rounded lip suffulting the glomerules of the flowers; the branchlets in the herbarium specimen with their seriate alveoles and lower projecting lip resemble a coarse rasp.

The *flowers* are ternate in the alveoles from the base to the apex of the branchlets; but the two males of each glomerule open a long time before the female; only one of the males is furnished with a triangular, erect, acute, dorsally keeled, bract; the female flower (of each glomerule) has two bracts, larger than that of the male, and all, like the flowers, are tinged with mahogany red.

The *male flowers* of each group are collateral and open in succession; the fully developed buds have their bases inserted in their respective alveoles, are 6 mm. long, 2 mm. broad, narrowly oblong, bluntish, and tapering towards the base. They are somewhat angular and irregular from mutual pressure; *sepals* entirely free, slightly imbricate at the base, linear-spathulate membranous-scarious with hyaline margins, cucullate, and rounded at the apex, very acutely keeled on the back. Corolla, somewhat less than twice as long as the calyx, divided from about the middle upwards into three narrowly spathulate segments, which are concave, slightly thickened, valvate, bluntish or roundish at the apex and of the same texture as the sepals; the corolla in its lower, undivided half is tubular-cyathiform and tapers to a narrow base. The stamens form a rather long column, divided above into six short and relatively thick filaments, radiating at about a level with, or a little above, the corolla at the time of the anthesis. Anthers basifixed and erect in the bud, introrse, con-

spicuously biauricled, or cordate-sagittate, acute with the cells slightly divaricate, united by a broad black connective; the rudiment of the ovary is represented by a small trilobed tubercle, placed on the summit of the staminal column, in the center, between the radiating filaments.

The *female flowers*, when the males open, are very little evolute and are pressed between and behind these; I have not seen them at the time of flowering, but judging from the perianths at the base of the fruits they appear to be 4 mm. long and with the sepals scarious, imbricate, lanceolate and very

Figure 146. Calyptrogyne swartzii, a, portion of flowering branchlet, one male flower is open, the others are still closed; b, entire male flower during the anthesis; c, male flower from which a portion of the corolla has been removed; d, very young female flower; e, urceolum enveloping the ovary, formed by the staminodes from the above female flower; f, fruit with its perianth; g, fruit with its perianth removed to show the remains of the abortive carpels at its base; h, the putamen. The flowers from Wright No. 1466; the fruit from Van Hermann No. 875.

sharply keeled; the petals are also scarious, somewhat longer than the petals, imbricate at the base and with valvate apices. From what can be judged by the very young female flowers, the staminodes form a thin, membranous, conical tube, entirely enveloping the ovary and crowned by six narrow teeth. The ovary is trigonous and narrows abruptly into the style, which is divided into three linear stigmas.

Fruit (when dry) broadly ovoid, about 1 cm. long, 8 mm. broad, with a smooth surface and rounded at both ends; it bears the remains of the sterile loges, and of the style, at its base in the form of an inconspicuous tubercle

hidden by the perianth; the pericarp is somewhat wrinkled in the mature dry fruit; epicarp thin, membranous; mesocarp apparently somewhat fleshy with an internal fibrous layer; this last, combined with the endocarp, forms a shell or putamen to the seed, easily detachable from the pulpy tissue; the putamen is obovate, rounded above, acute at base, slightly flattened, keeled at each side, 9 mm. long, 6 mm. broad, 5 mm. thick; the outer covering of the putamen is rendered coarsely reticulate by a few relatively large, looping, fibrous strands adhering to the very thin cartilaginous endocarp. The *seed* is suborbicular, broader at the base than above, slightly flattened or sublenticular, 6 mm. long, 5 mm. broad, 4.5 mm. thick; it has a smooth blackish surface; the hilum is linear and is continued all round the edge of the seed in a narrow whitish line (the raphe?); albumen homogeneous, finely radiate and also faintly ringed by numerous minute concentric layers; embryo exactly basilar. (Fig. 146.)

I have reduced to only one species the *Calyptrogynes* growing in Cuba, Jamaica and S. Domingo, which have been considered as belonging to two or three distinct species. The oldest name for this palm is *Elaeis? occidentalis* Swartz, of which Grisebach made his *Geonoma* or *Calyptronoma swartzii;* it is this specific name which I propose to adopt, and which I consider as embracing all the other (supposed) species.

Of *Geonoma plumeriana* Mart. I have seen in the Berlin Herbarium a copy of Plumier's plate, upon which the species was founded, and in which it is easy to recognize *Calyptrogyne swartzii* by its characteristic cylindrical, elongate, flowering branchlets. The fruits are represented as globular, 14-15 mm. in diameter and, possibly, when the fruits are thoroughly mature they do assume this form. In one of the plates the general appearance of the plant is shown, from which it appears no larger than the plant of Cuba, but with gregarious stems.

Specimens from S. Domingo collected at S. Lorenzo, Samana Bay (Taylor n. 97, Herb. Berol.) exactly agree with the Cuban specimens with large leaflets.

From Jamaica I have examined Harris n. 9842 (Herb. Berol.), Farm Morass near Black River. In these specimens some of the flowering branchlets are larger than usual, as much as 30 cm. in length, and 1 cm. in diam.; but other branchlets are of the usual size. In the flowers I have not discovered the slightest difference from those of the Cuban specimens. The very immature fruits are obovate-oblong, 12-14 mm. in length.

On number 3972 of Wright has been established *G. intermedia*, and under this same name have been distributed Curtiss n. 485 from the Isla de Pinos. Of number 3972 I have seen no specimens, and those of Curtiss are in no way distinguishable from those of Wright's n. 1466; the leaflets are 70 cm. long, 3.7 cm. broad, and have 7-8 nerves, only the branchlets are somewhat shorter than usual (12-15 cm. long). Furthermore I have not been able to discover diagnostic characters of any value to render a specific differentiation possible amongst the numerous specimens of *Calyptrogyne* gathered in different parts of Cuba. I have found that the size of the leaflets and the number of their nerves is very variable in specimens collected in the same region. I may

mention those gathered by Baker and Dinmock (n. 4882) between Paso Real y Herradura, from the same place where was taken the photograph reproduced in Fig. 145, which have the intermediate leaflets with 7-8 nerves, or as many as in Wright's n. 1466, considered as *C. swartzii* by Grisebach himself; whereas another specimen gathered in about the same region with the preceding, at Herradura, by van Hermann (n. 875), but probably obtained from a plant growing in less favorable conditions of ambient, has the intermediate leaflets 35-40 cm. long, 15-17 mm. broad and with 4-5 nerves only; these specimens, therefore, would be considered as of *C. dulcis*. In the spadices I have found only slight differences in the dimensions, and these chiefly in the length of the branchlets, between the specimens of the two localities.

The Cuban specimens of *Calyptrogyne* I have examined are: Herb. *Baker* n. 4882 as quoted above (Herb. Berol. et Becc.); the, also, already mentioned *van Hermann* n. 875, Herradura (Herb. Becc. and Berol.); from these last specimens I have described and figured the fruit; *Baker* n. 3050 (in Herb. Becc.) at Baracoa, Prov. Santiago de Cuba; *Wright* n. 1466 (in Herb. de Cand.) from the east of the island, distributed under the name of *Geonoma* (*Calyptronoma*) *swartzii* Gr. et Wendl; this I used for the description of the flowers and their analyses; *van Hermann* n. 745 (Herb. Berol.), Provincia Pinar del Rio; *Curtiss* n. 485 (in Herb. de Cand. and Berlin), Isla de Pinos. Of Wright's n. 3972, referred by Sauvalle, Fl. Cub. n. 2387, to *Geonoma intermedia* Gris. et Wendl., I have seen no specimens.

ACROCOMIA Mart.

Mart. Hist. nat. Palm. II, 66, and III, 285; Drude in Mart. Fl. Bras., III. II. 388; Benth. et Hook. Gen. plant, III. 943. **Gastrococos** Morales in Repert. fisico-natural de la Isla de Cuba, I (1865), p. 57-64 (ex sched. Urbanianis).

A very rigorous examination of the numerous specimens of *Acrocomia*, derived from almost every island of the Greater and Lesser Antilles has led me to the conclusion that in these islands only two distinct species of *Acrocomia* grow wild. One of these, *A. crispa*, is apparently endemic in Cuba; the other is widely dispersed in the islands to the east, and especially in the Lesser Antilles. I believe, therefore, that all the specific names attributed to the *Acrocomia* existing in the Antilles (except in Cuba) are to be reduced to only one, i. e. to the oldest, which is, I think, *Cocos aculeata* (*trunco foliisque aculeatis*) Jacq. Amer. (1763), p. 278, t. 169 (non vidi); edit. pict., p. 135, t. 254 (ex Mart.); Willd. sp. pl. IV, p. 401. I consider the *Cocos fusiformis* Swartz, Fl. Ind. occ. I, p. 616 (1797), as exactly the same plant as that of Jacquin (mentioned above) against the opinion of Swartz himself, who, at first, (novas Gen. et sp. plant. seu Prodr., 1788, p. 151) had reduced to *C. aculeata* the plant which, afterwards, he named *C. fusiformis*, as he could not believe it possible that Jacquin had overlooked the character of the fusiform trunk, possessed by the *Acrocomia* of Jamaica and Hispaniola, to which Swartz, just for that reason, had applied the name of *C. fusiformis*. But the trunk of *Acrocomia* (*Cocos*) *aculeata* is very variable as to its forms, and in the same

Island of Porto Rico, while it is frequently, more or less, fusiform, it is also at times, quite cylindrical. An unpublished picture by Krug in the Herbarium at Berlin shows it thus.

I do not think the name of *A. fusiformis* at all applicable to the plant of Cuba, which has the trunk almost smooth, the spines being detachable and deciduous; while the spinescence described by Swartz for his *C. fusiformis* is exactly the same as that which covers the trunk of *C. aculeata.*

The fruit described by Swartz as that of his *A. fusiformis* (drupa . . . . oblonga) is certainly that of a quite different plant, and is, very probably, as supposed by Martius, the fruit of *Syagrus* (*Rhyticocos*) *amara.*

To be enabled to decide on the right names to be assigned to each of the two species of *Acrocomia* of the Antilles I have passed in review all the known species referable to that genus, and I have been able to recognize that, although all the *Acrocomia* are very similar in general aspect, they nevertheless offer good diagnostic characters in their flowers, both male and female, by which the species may be easily distinguished.

Conspectus of the Species of Acrocomia

1. *Acrocomia aculeata* Lodd. ex Mart. Hist. nat. Palm. 286.
   (*A. fusiformis* Sweet).....The Antilles except Cuba
2. *Acrocomia crispa* (H. B. et K.) C. F. Baker in exicc.
   (*A. cubensis* Lodd.—nomen; *A. lasiospatha* Auct. plur.).....Cuba
3. *Acrocomia glaucophylla* Drude in Mart. Fl. Bras. v. III, II, 392.....
   .....Brazil (tropical and subæquat.)
4. *Acrocomia intumescens* Drude in Mart. l. c. 391.....
   .....Brazil (Prov. Rio de Janeiro)
5. *Acrocomia lasiospatha* Mart. in Palm. Orbign. 81.....Cayenne
6. *Acrocomia mexicana* Karw. ex Mart. Hist. nat. Palm. III, 285, t. 138
   (*A. zapotecis* Karw.).....Mexico
7. *Acrocomia sclerocarpa* Mart. Hist. nat. Palm. II, 66, t. 56, 57, 100 f. 5.
   (*A. sphaerocarpa* Desf. ex Ind. Kew.).....Brazil (Rio de Janeiro)
8. *Acrocomia wallaceana* Becc.
   (*A. sclerocarpa* var. *wallaceana* Drude; *A. lasiospatha* (non Mart.) Wallace Palm trees t. XXXVIII).....Brazil (Para)
9. *Acrocomia totai* Mart. in Palm. Orbign., 78, t. 9 f. 1.....Bolivia
10. *Acrocomia vinifera* Oerst. in Kjoeb. Vidensk. Meddel. (1858) 47.....
    .....Nicaragua
11. *Acrocomia mokayayba* Barb.-Rodr. in Pl. nov. Rio, v. II.....
    .....Brazil (Prov. Matto grosso)
12. *Acrocomia odorata* Barb.-Rodr. Palmæ Mattogr, 48.....
    .....Brazil (Prov. Matto grosso)
13. *Acrocomia microcarpa* Barb.-Rodr. in Vellosia, 1885-88, ed. 2, I (1891), 107.....Brazil (Amazonas)
14. *Acrocomia crioacantha* Barb.-Rodr. Contr. Jard. bot. Rio, I, 85.....
    .....Brazil (Amazonas)
15. *Acrocomia antioquiensis* Posada-Arango in Bull. Soc. bot. de France, v. 25 (1878), 183 . . . . . Antioquia in Colombia

Figure 147. Acrocomia crispa.

Acrocomia gujanensis Lodd. (nomen).....Guiana=*A. lasiospatha* Mart.?
Acrocomia minor Lodd. ex Don in Lond. Hort. Brit, 382.....Quid?
Acrocomia horrida Lodd. (nomen).....Trinidad=*A. aculeata* Lodd.?
Acrocomia globosa Lodd. (nomen).....St. Vincent=*A. aculeata* Lodd.?
Acrocomia tenuifrons Lodd. (nomen)....St. Domingo=*A. aculeata* Lodd.?

Acrocomia crispa C. F. Baker exicc., n. 4566. **Cocos? crispa** Humb. Bonpl. et Kunth, nova Gen., I, (1815), 302; Mart. Hist. nat. Palm, III, 324; Kunth, Enum. pl. III, 287. **A. cubensis** Lodd. ex H. Wendl. Ind. Palm. I, (nomen). **A. lasiospatha** (non-Mart.) Gris. Cat. pl. cub. *222* (Wr. n. 3223—non quoad Fl. Br. W. Ind. 521); Sauvalle, Fl. cub. p. 153, n. 2389. **Astrocaryon** sp. n. sec. Wendl. et **Cocos armentalis** Morales ex Sauvalle Fl. Cub., p. 153, n. 2393. **Astrocaryon crispum** G. Maza in nociones de Bot. (1893), 50. **Gastrococos armentalis** Morales l. c.

The Cuban *Acrocomia* is a most remarkable palm, being one of those in which the bulging of the trunk in its upper aerial part is pre-eminently great (Fig. 147). As far as I can judge from the picture, the trunk is about 10 metres in height, and 25-30 cm. in diameter at its base; thence it gradually swells to nearly three times the thickness of its basal diameter; the greatest diameter (about 70 cm.) being attained at 6-7 m. above the ground, thence the trunk tapers again gradually, but in a much lesser degree than below; its general aspect therefore cannot truly be termed fusiform, but is rather that of an enormous club; in its lower and older part the surface looks rough and corky; above it is obscurely and closely ringed by the leaf-scars, otherwise it is smooth; it must, however, have been more or less permanently covered by spines, but these seem easily detachable, and only a few remain visible in the photograph. The crown of leaves is dense, but in proportion to the volume of the stem it is relatively small. The lowest leaves drop off at every emission of new spadices, and leave the trunk clean, with the spadices hanging below the crown, when loaded with fruit.

The *leaves* on the whole seem to be about 3 m. long, have their bases much and suddenly enlarged, very thick, short and broad, and widening in their lower parts so as to embrace the trunk; petiole very short or almost obsolete; rachis glabrous, apparently not much armed, being quite spineless in the small portions seen by me. Leaflets very numerous, arranged, more or less distinctly, into approximate pairs on each side of the rachis; each pair is obliquely inserted in contrary ways on the rachis, and the blades extend in two different planes. The leaflets are firmly papyraceous, ensiform, and quite straight, and gradually narrow from a rather considerable distance below the middle, to a very long-acuminate, very briefly bifid apex; they taper also, but slightly, towards the base, are green, and almost glossy in the upper surface; the lower surface is paler or slightly glaucescent, and especially in the newly expanded leaves, which, when seen under a strong lens, show themselves covered on all the numerous tertiary nerves with extremely minute hair-like corpuscles, not always easily discernible; the mid-costa is strong, prominent above and frequently furnished with a bristle-like spinule at its base, superficial and smooth

below; on each side of the mid-costa are 3-4 slender secondary nerves; the tertiary nerves are numerous, especially distinct underneath; the middle leaflets are 70-75 cm. long and 25-30 mm. broad; the margins are not, or only very slightly thickened; the transverse veinlets are very much interrupted, and usually too much immersed in the parenchyma to be visible.

I have not seen the spathes. The *spadices* on the whole are about 1 m. long, of which about 30 cm. are occupied by a robust peduncular part, and when in fruit form enormous, elongate, pendulous, grape-like bunches, about 70 cm. in length, and about 25 cm. in diameter at their bases, being somewhat less in their apical parts. The flowering branchlets are 20-30 cm. long, very densely and spirally arranged round the main axis, have a distinct callus at their axilla, and are suffulted by a very small bract; they are sinuous, glabrous, subterete, 3-5 mm. in diameter in their basal part, where they carry 4-5 female flowers only; are angular but about of the same diameter in their upper two-thirds, where they are deeply scrobiculate and densely covered with the male flowers. The scrobiculi are arranged in six longitudinal series, and are not contiguous, those of each series being 2-3 mm. apart from one another, they have their lower margin bracteiform, concave like a swallow's nest, rounded, and projecting horizontally about 1 mm.

The *male flowers* appear to be geminate in each scrobicule, from the scars left by their fall, but none remained on the specimen seen by me.

The *female flowers* in bud are broadly conical, 8 mm. high (judging from the perianth of the growing ovaries); the calyx is almost flat, suborbicular, slightly three-lobed, about 7 mm. in diameter; the corolla is parted nearly down to its base into three very broadly subcordate lobes, which are slightly imbricate at the base, have the margins entire, and triangular, rather acute apexes. The staminodes form a complete cup about as long as the corolla, irregularly and not very deeply three-lobed, the lobes are broadly triangular and occasionally terminated by a rudimentary anther; three of the lobes are very conspicuous between the divisions of the corolla. The pulvinuli of the female flowers are flat, orbicular, 3-5 mm. in diameter and surrounded by the bracts which form a narrow ring, and bear above them the very short pedicels which suffult the two male side flowers. The ovary is covered by silvery appressed hairs, is broadly ovoid with a conical apex terminated by three circinate stigmas.

The *fruit* is spherical, 3 cm. in diameter, very slightly depressed on the apex, where it bears the remains of the stigmas, a very small three-lobed papilla. The outer coating or epicarp of the ripe fruit is thinly crustaceous, brittle, of a yellowish ochraceous color (when dry), almost polished and only rendered very obscurely uneven by minute granules resting under its tissue; the mesocarp is slightly parenchymatous with its inner layer traversed by very minute slenderly filiform, sinuous, much branched fibres, especially numerous near the base. The putamen is somewhat irregularly globose, or else obsoletely trilobed and slightly depressed, 20-22 mm. broad, 18 mm. high; its surface is of a plumbeous color, uneven, coarsely and slightly pitted; the

foramina are at regular distances in the middle of the periphery; the cavity is irregularly three-lobed, 16 mm. in width in its broadest part; the wall of the shell is 3-4 mm. thick; the cavity of the only fruit I had at my disposal had a general subcordate outline, but was empty.

The *fruiting perianth* is not accrescent, and is quite explanate under the fruit. (Fig. 148.)

A. crispa grows wild in Cuba as isolated individuals. The photograph reproduced in Fig. 147 was taken at Santiago de las Vegas near Havana, whence Prof. Baker's sterile specimens bearing n. 4566 are derived. My description, however, is based on Wright's specimens of the "Plantæ cubenses" bearing the n. 3223 (in Herb. de Candolle) distributed under the name of *A. lasiospatha* Mart. ex Gris. Cat. cub. 222. The native name of this palm in Cuba is "Palma Corojo" (Baker).

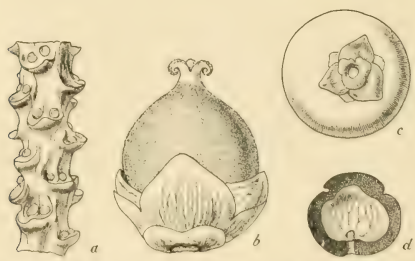


Figure 148. Acrocomia crispa. a, portion of an empty male flower-bearing branchlet; b, a growing ovary; c, fruit as seen from its base; d, transverse section of a seed. From Wright No. 3223. Fig. a, b, enlarged; c, d, natural size.

The *Acrocomia* endemic in Cuba is rendered very distinct from all the other species belonging to this genus, at least from those known to me, by its male flowers being in pairs in each alveole, and by the alveoles not being in contact with one another; in all the other species the alveoles form by their ensemble a kind of honey-comb, with a single male flower in each cell and with the margins of the cells more or less produced into bracteiform wings.

From the other *Acrocomia* growing in the Antilles, *A. aculeata* (Jacq.), *A. crispa* differs not only in the characters just now mentioned, but also in its very conspicuously inflated stem and in the fact that the stem is only temporarily covered with spines; also by the leaves being far less spinous in every part; by the female flowers having their petals cordate-triangular and entire; by the staminal urceolum with six broad triangular lobes which, on the whole, look like a second corolla; and finally by the ovary being covered by a silvery indument which is formed by very appressed scale-like branched trichomes.

Furthermore the fruit of the Cuban *Acrocomia* is smaller than that of *A. aculeata*, and the fruiting perianth has the pieces of the corolla triangular, rather acute, and entire, not lobed and crenulate as are those of *A. aculeata*.

Generally the *Acrocomia* of Cuba has been known under the name of *A. lasiospatha*, a name which was originally applied by Martius to a species growing at Cayenne; but to it he also appended the synonym of *Palma cocifera caudice tumido et aculeato* of Plumier, reproducing also the description left by that author; in this description, however, it is easy to recognize the *Acrocomia* growing in the island to the east of Cuba, provided we take into account his description of the fruits, of which it is said that they are "pila lusoria paullo minores", that is to say, of about the size of a small billiard ball; these dimensions are never attained by the fruit of *A. crispa*, while they really are approached by those of *A. aculeata*. The localities given by Plumier for his *Palma cocifera* (Martinique, San Domingo and S. Vincent) are also an argument in favor of its identification with *A. aculeata*.

As I consider that not the slightest doubt can now remain as to the identity of *Cocos? crispa* H. B. et K. with the Cuban *Acrocomia*, I think that the name of *A. crispa* may be considered as the most appropriate one.

Acrocomia aculeata Lodd. ex. Mart. Hist. nat. Palm. III, 286 (excl. syn. **A. sclerocarpae**). **A. fusiformis** Sweet. Hort. Brit. ed. I, 432 (ex. Ind. Kew.) **A. fusiformis** Maycock, Fl. Barb. (1830), 355 (excl. descript. fol.). **A. funiformis** Baill. Hist. des plant, 304, e Jamaica (psalmate pro **A. fusiformis?**). **A. lasiospatha** Mart. Palm. Orb., 81, et Hist. nat. Palm. III, 286 (tantum quoad citatum Plumierii: **Palma cocifera caudice tumido et aculeato**); Griseb. Fl. Brit. W. Ind., 521 (partim?). **A. sclerocarpa** (non Mart.) Griseb. l. c.; Bello, Apunt., II (1833), 114, n. 771 (ex Urban, Symb. Ant.) **A. media** O. F. Cook in Bull. Torrey Bot. Club, XXVIII (1901), 566; Urban, Symbolae Ant., IV, 130; Cook et Coll. Econ. pl. Port, 67. **Cocos aculeata** Jacq. Select. Amer. (1763), 278 (non vidi), et in Willd. sp. pl. IV (1805), 401; Swartz Nova Gen. seu Prodr. (1788), 151 (una cum syn.) **C. fusiformis** Swartz Fl. Ind. occid. I (1797), 616, (una cum syn. sed excluso fructu).

Stem 10 to 15 m. high, and 20-30 cm. in diameter, more or less fusiform in its middle part, but at times almost cylindrical throughout, armed with close rings of robust, black, very sharp spines.

The *leaves* have the leaflets polished above, dull and more or less whitish beneath, rather brittle, and easily splitting longitudinally; those of the intermediate part of the rachis 70-75 cm. long, 3 cm. broad; the rachis is very powerfully armed with black, very unequal spines, some of them being as much as 10 cm. in length, flattened, covered with a rusty woolliness in their basal part, otherwise polished.

The inner *spathe* is densely covered with very fine, soft, brown hairs, mixed occasionally with a few spines.

The *spadix*, on the whole, is 1 to 1.5 m. long; the peduncular part is armed with spines 5-12 mm. long which are covered with rusty woolliness in their lower part, their points being of a shiny black. The branches of the spadix are

very numerous, 25-30 cm. long, somewhat swollen at the base, otherwise subterete, or slightly flattened, 4-6 mm. thick, and slightly sinuous in their lower third, or fourth, part, where they carry 2-5 female flowers; the part bearing the male flowers is 16-20 cm. long, and about 15 mm. in diameter, when bearing the flowers; its axial part alone is 7 mm. broad, very closely, regularly, and deeply hollowed by rhomboidal alveoli; each contains one flower only, has narrowly winged margins, and the lower lip protrudes 1-1.5 mm.

The *male flowers* are each furnished with a very small triangular bracteole; their fully developed buds are 7 mm. in length, are oblong, rounded above, and slightly narrowing towards the base; the calyx is small, the sepals are slightly imbricate at the base, 1.5 mm. long, are membranous with hyaline margins, deltoid, acute, entire or faintly ciliate-denticulate. The corolla is divided down to a little past the middle into three ovate, concave, more or less acute, rather thickly coriaceous segments, each having a callous thickening at its base internally. Stamens six, inserted just at the mouth of the corolla where the segments separate one from the other; the rudimentary ovary is formed by three small elongate bodies placed between the bases of the stamens; below the insertions of the stamens the body of the corolla is solid and fleshy; the filaments are terete, subulate, about as long as the segments of the corolla, and with the apex briefly inflected when in the bud; anthers elongate-rectangular, equally rounded at both ends; during the anthesis the loges remain open and applied one against the other by their backs. (The loges must open when the flowers are still very young, as I have found them in that condition even when the corolla was not yet open.)

The *female flowers* have very broad bases and are almost globular, being about 1 cm. high and about as broad; the calyx, on the whole, forms a very narrow ring, and is formed by three sepals, very narrow, semi-circular, with hyaline margins. Petals large, imbricate, suborbicular, three-toothed at the apex, the middle point being rigid, very acute, and almost pungent, the side points are, like the margins, hyaline and irregularly ciliate-toothed; the staminal urceolum is very short and truncate; ovary globose-ovoid, narrowing above, densely hairy-hispid from the base to the stigmas; these are circinate.

Fruit globose, slightly depressed, about 4 cm. in diameter, but apparently, judging from some of the kernels, at times larger; it is 3 cm. high and has a small papilliform apical mucro; it has a polished surface, and when dry is of a dirty-yellow color. The epicarp is brittle, two-thirds of a millimeter thick; the mesocarp in the dry condition is rather soft, adherent to the putamen, almost corky in texture, and without rigid fibres. The putamen is depressedly globose, 25-28 mm. broad, 20-21 mm. high; the pores are about in the middle of the periphery; the surface is uneven, venose-impressed, marked below by three very faint and shallow grooves which radiate from three very small holes placed in the center of the base; of the upper surface the center is slightly raised and obsoletely apiculate. The wall of the shell is 3-4 mm. thick. *Seed* usually solitary, but at times two collateral seeds are to be found within the same shell, separated by a woody dissepiment. When the seed is

solitary, the cavity is very obsoletely three-lobed in transverse section, and 18 mm. in breadth. The seed (when solitary) is obsoletely subcordate-three-lobed, slightly flattened, with a brown venose-impressed surface. Albumen oily, equable, with a small central cavity, perfectly white; it is rather hard, but it may be cut with a knife.

Fruiting perianth explanate, with the petals crenate-lobed on the thinned margins, slightly callous and gibbous at the base. (Fig. 149.)

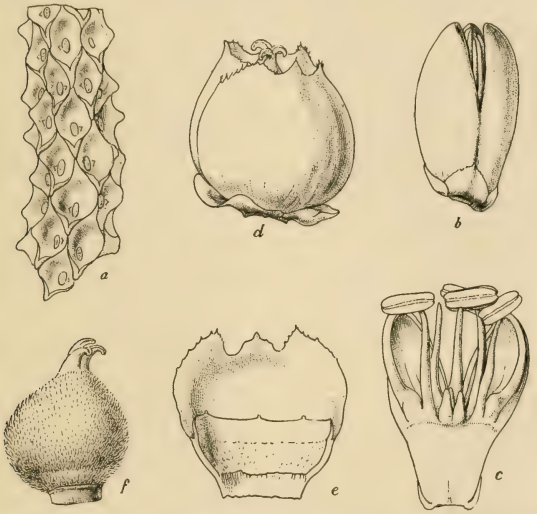


Figure 149. Acrocomia aculeata, a, portion of an empty male flower-bearing branchlet; b, male flower; c, male flower from which a portion has been removed to show the insertion of the stamens and of the sterile ovary; d, female flower; e, section of the corolla to show its inner side, and the cup formed by the staminodes; f, detached ovary during the anthesis. From a specimen collected by Sintenis in Porto Rico.

Acrocomia aculeata has been often considered as not differentiating from *A. sclerocarpa* Mart., and on this subject Martius (Palm. Orbign. 81) writes that a branchlet with male flowers coming from Porto Rico and named *Cocos aculeata,* hardly presents any character by which it may be distinguished from *A. sclerocarpa.* But *A. aculeata* differs from *A. sclerocarpa* by the fruit of the first being larger, and having the perianth almost explanate, the bases of the

petals being only slightly swollen. In *A. sclerocarpa* the petals of the fruiting perianth are strongly swollen, or conspicuously callous. In *A. aculeata* the lower lip of the scrobicules is not much produced, while in *A. sclerocarpa* it is bracteiform or liguliform, and 4-5 mm. in length. The ovary in *A. aculeata* is hairy from its base to the origin of the stigmas; in *A. sclerocarpa* it is densely hairy in its lower part only and glabrous above. The ring formed by the staminodes in *A. aculeata* is perfectly truncate, while it is distinctly six-toothed in *A. sclerocarpa.*

I have especially described the palm growing in Porto Rico known by the vernacular name "Palma de Corozo", and of which Mr. O. F. Cook has made his *A. media.* I have, however, examined also numerous other specimens collected in various of the Greater and Lesser Antilles, which all seem to me referable to *A. aculeata.*

From Porto Rico I have seen: *Sintenis* n. 3972, 4935, 6483 (Herb. Berol.) *Bertero* also collected this palm in Porto Rico and fragmentary specimens of it are preserved in the Herbaria de Candolle and of Berlin. In the latter, one specimen bears the n. 286, and comes from the Herbarium Sprengel; another comes from the Herbarium Kunth; all are labelled *Cocos aculeata.*

Jamaica: *Harris* n. 9943 (Herb. Berol.) near Malvern, 730 m. alt.; the flowering branchlets are exactly as in the plant of Porto Rico.

Haiti: In the plain near St. Michel leg. *W. Buch* 1907 (n. 3 in Herb Krug et Urban). Habitus *Oreodoxa regia* Fructus flavi, edules. The fruits are 37-40 mm. in diameter. The seed is 26 mm. broad, 23 mm. high. The fruiting perianth is exactly as in the plant of Porto Rico.

Tobago: *Eggers* n. 5739 (Herb. Berol.) "Grougrou" incol. Common on the River Bacolet. The fruit is said to be 38 mm. in diameter, and to be edible; the specimen has only a portion of a leaf, corresponding to those of the plant of Porto Rico.

Guadeloupe: *Pere Duss* n. 3805 (Herb. Berol.) Plains and marshes of the Lamentin, Vulgo "Dinde". The flowers and fruits, 4 cm. in diameter, are exactly like those of the plant of Porto Rico. In a note Pere Duss describes the leaves as 3-4.5 m. long with segments on two series; the entire plant 10-17 m. high with a straight trunk; this is swollen at the base in young individuals, but in the middle in those older, and in the very old ones near the summit; the trunk is marked by annular rings, and furnished with spines. The spadices are at first erect, then recurved, 1 to 1.30 m. in length, and bear 80-100 flowering branchlets. The flowers are yellow and exhale a bad smell. An entire spathe is 1.20 m. long, very densely velutine, quite devoid of any kind of spines.

Dominica: *Eggers,* March 1882, "Grou-Grou" inc. (H. Berol.), only leaves of young plants which do not show differences from analogous leaves of the same age from Porto Rico. Also *Eggers,* Goodwill Valley, 23. 2. 1880, as above.

Martinique: *Pere Duss,* Riviere Salée, Ducos, Lamentin, vulgo "Glouglou" (Herb. Berol.) Leaves as in the plant of Porto Rico. The spathe

is velutinous, but is sprinkled with a few elongate black spines. The male and female flowers exactly as in the plant from Guadeloupe. Ovary hispid in the usual way. Fruits 40-42 mm. in diameter. Fruiting perianth with crenulate petals.

Grenada: *Eggers* n. 6302 in Herb. Berol. From near sea level to about 180 m. elevation between Goyave and Grand Pauvre. "Grou-Grou" inc. The specimens consist of flowering branchlets, portion of the leaves and detached spines of the trunk; everything as in the plants of Porto Rico.

BACTRIS Mart.

Bactris plumeriana Mart. Palm. Orbign. 64, and Hist. nat. Palm. III, 280; Griseb. Pl. Wright, 531, and Cat. plant Cub., 222; Sauv. Fl. Cub., 153, n. 2390.

A small tree apparently forming small thickets, with stem 8-10 cm. in diameter and 4-6 m. high, densely covered with very rigid, slender, unequal spines, 10-15 cm. long or less.

Leaves conspicuously interruptedly pinnate. Petiole rather elongate, armed densely with very irregular needle-like black spiculæ; leaflets numerous, approximate in groups of three to nine, about 1 cm. apart in each group, with rather long vacant spaces between the groups; they are firmly papyraceous of about the same color on both surfaces, inserted at an angle of about 45°, and all in one plane; the intermediate leaflets are 55-60 cm. long, 20-23 mm. broad, linear-ensiform, quite straight, somewhat narrowing to a rather acute base; here their margins are strongly reduplicate, but otherwise they have the blade flat, very gradually acuminate above to an unsymmetrical apex, the upper margin being prolonged 2-5 cm. beyond the lower one; the apex appears therefore two-toothed, but with one of the teeth linear, 2-3 cm. long, and the other very short and obtuse; on the upper surface the mid-costa is prominent, acute, and irregularly armed with a few distant black, stiff, subspiny bristles (5-8 mm. long); on the under surface the mid-costa is slender, and minutely hairy throughout, sometimes, however, inconspicuously; the secondary nerves are in number 3-4 on each side of the mid-costa; the tertiary nerves are numerous and sharp and render both surfaces, but especially the lower one, conspicuously longitudinally striate; in addition on these under surface nerves are aligned innumerable, extremely minute, hair-like squamules, frequently of a rusty color; the margins are acute, rendered irregularly and remotely ciliate by subspiny bristles, similar to those of the mid-costa. The rachis is rusty-furfuraceous, and rather densely armed all round with unequal, black, and very slender, spiculæ of which the largest are 3-4 cm. long.

The *spadices* are 25-40 cm. long, arched, and have two persistent coriaceous spathes, of which the outer is short, 8-12 cm. long, oblong, strongly flattened, hairy-hispid externally, broadly and acutely two-edged, or with a wing-like expansion at each side; the inner spathe is 3-5 times as long as the outer, and it broadens from a narrow sheathing base into a spathulate-cymbiform limb, 4-5 cm. broad, and ending in an acuminate tip; this spathe is thinly coriaceous but of a rather brittle texture; glossy and cinnamon-brown inside, externally it

is thinly tomentose, and densely covered with stiff, very fine, black spiculæ, mostly deflexed. The panicle is 10-15 cm. long, formed by several simple flowering branchlets, and borne on a curved peduncular part, as long or longer; this is 8-10 mm. thick, densely hispid, or covered by spiculiform bristles; is furnished above, immediately below the panicle, with a loosely sheathing cyathiform bract, of which the irregularly truncate mouth is produced into 2-3 irregular, broad-based, subulate teeth. The flowering branchlets are all almost of the same length, 8-12 mm. long; at first fastigiate; later, when they are loaded with fruits, spreading; they are filiform, 1.5-2 mm. in diameter at the base, thickening to 3 mm. when bearing fruit, subulate at the apex, slightly sinuous, terete, covered at first by a dense, rusty-furfuraceous, pulverulent indumentum, formed by small papillæ which become partially deciduous by age. During the flowering time the axial part of the branchlets is entirely hidden by the flowers, which are very closely packed together.

The *male flowers* are more numerous than the female, have very inconspicuously hyaline bracts at their bases, are superficially inserted on the branchlets, and solitary on each pulvinule; they are rendered very unsymmetrically three-gonous by mutual pressure, 4 mm. long and about as large; the calyx is small, membranous, and has three narrow acute teeth; the corolla is much longer than the calyx, fleshy, divided almost to the base into three valvate, deltoid, acute, flat segments; stamens six, filaments short, anthers linear, obtuse at both ends; rudiment of an ovary inconspicuous, punctiform.

Female flowers scattered among the male flowers; apparently each female flower is accompanied by two male flowers, but the glomerules are not regular; at the time that the male flowers are about to open, the female flowers are 2.5-3 mm. long, and apparently are ready to be fertilized; they are cylindraceous, probably thinly fleshy when fresh, membranous and of a lighter color than the males in the dry herbarium specimens; the corolla is about three times as long as the calyx, and thicker than this, tubular, slightly campanulate, obsoletely striately-veined (when dry), three-toothed, the teeth broadly triangular, acute, and connivent; ovary clavate-oblong, rounded above, and surmounted by a conspicuous, quite sessile, convex suborbicular papillose stigma; the corolla is accrescent after the fertilization of the ovary, and becomes broadly campanulate, 3 mm. high, 5 mm. broad, truncate and very obsoletely three-denticulate at the mouth, but in time becomes explanate under the mature fruit; it is then 7 mm. in diameter, more or less split into three strongly striately-veined lobes.

Fruit, globose, slightly depressed, 11-12 mm. in diameter, and about 2 mm. less in height, with the papilliform remains of the stigma in the center of the slightly depressed apex; in the dry condition it is yellowish and more or less sharply, longitudinally striate; the pericarp on the whole is very thin; the epicarp very thinly pellicular and adherent to the mesocarp; the mesocarp is very scanty, possibly slightly fleshy when fresh, it has only a layer of unequal fine fibres, which give a finely striate appearance to the dry fruit. The putamen has a smooth black surface and three pores placed a little above the

middle; its wall is very thin, 0.5-1 mm. thick; it contains only one seed, which is globular, slightly flattened, very superficially lobed, 10 mm. in diameter, 7.5 mm. thick. Albumen not very hard, white, slightly oily; embryo basal.

I have based my description chiefly on the specimens of the "Plantæ Cubenses Wrightianæ", n. 1465 in Herb. de Candolle. In the Berlin Herbarium I have also seen a fruiting specimen collected by Gundlach in Oriental Cuba, one from the New York botanical Garden collected by Shafer (n. 3555) on Sierra Nipe near Woodfred, Oriente, Pinelands, 500-650 metres altitude, and another (Shafer n. 1750) from the Pinales, S. E. of Paso Estancia, Oriente. Very slightly differing from the above is one I have received from Prof. Baker (n. 3051) collected by W. T. Horne at Baracoa, Prov. Santiago de Cuba. In this specimen the fruiting perianth is slightly smaller than in Wright's type specimens (6 mm. in diameter) and is not split into three parts, or is at most, only superficially three-lobed; the leaflets bear only a few bristles here and there near the upper end, and on the mid-costa the spiculæ are present only near the base, and a few scattered near the apex; the upper leaflets shorten gradually and have the apex briefly and almost equally obtusely two-toothed. A very young plant collected by Eggers in Cuba (n. 5239) at La Prenda (800 m.) has primordial leaves which are deeply bilobed, acutely cuneate at the base, with the lobes acuminate, and 6-7-costulate; the petiole and the rachis are powerfully armed with unequal needle-like, black, nitent spiculæ, of which the largest are 2-3 cm. long; all the other nerves are smooth; the margins are irregularly spinulous. This palm is known in Cuba under the name of "Coco-Macaco".

I have not seen specimens of this palm from any other of the Antilles. I think that Grisebach had correctly identified the *Bactris* growing in Cuba with the *B. plumeriana* of Martius, who applied this name to the *Palma dactylifera aculeata minima* represented in Plumier's unpublished plates XLIII, XLIV, XLV. Of these plates I have seen a copy in the Berlin Herbarium and about them I have to observe that the spadix represented in plate XLIV bears fruits 10-11 mm. in diameter, or slightly smaller than those of the plant from Cuba.

Other species of *Bactris* are mentioned as proper to the Antilles, but I have not as yet made a special study of them.

SABAL Adans.

Adans. Fam. nat., II, 495; Becc. in Webbia di U. Martelli, II (1907), 10. **Sabal** and **Inodes** O. F. Cook in Bull. Torrey Bot. Club, 1901, 529.

A. All the primary divisions or segments of the leaves unicostulate and deeply bifid.

Divisions of the segments having a very acuminate, but rigid apex. Flowers oblong-ovoid, very small, 3 mm. long, 1.8 mm. thick. Fruit spherical, rounded at its base, 1 cm. in diameter. *S. parviflora*

Divisions of the segments having a very elongate filiform flaccid apex. Full-grown flower-buds narrow and elongate, 5 mm. long, 2 mm. thick. Fruit. . . . . *S. florida*

Figure 150. Sabal parviflora.

B. Leaves with the blade unequally divided, with several of the primary divisions three-costulate, and divided again into unicostulate bifid segments.

Full-grown flower-buds relatively large, obovoid with a rounded top, 4 mm. long, 2 mm. broad. Fruit globular, 9-10 mm. in diameter, narrowing a little towards a slightly bent base. *S. Yapa*

Sabal parviflora Becc. in Webbia di U. Martelli, II, 43. **S. mexicana** (non Mart.) Sauvalle, Fl. Cub. 152.

From the Fig. 150 the adult plant appears to be a fine palm with a rather robust, high and almost regularly cylindrical columnar trunk surmounted by a fine and dense crown of large leaves. The trunk is evidently thicker than

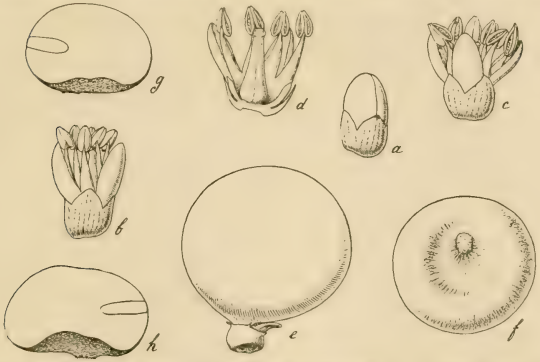


Figure 151. Sabal parviflora. a, full-grown unopened flower; b, c, flowers during the anthesis; d, longitudinal section of a flower; e, fruit; f, fruit as seen from the hilum side; g, h, seeds, median section through the embryo. Fig. a, b, c, d, e, g, from Curtiss No. 484; fig. f, h, from Wright No. 3970.

that of *Sabal palmetto*. From what I can judge by the photograph, the old leaves do not remain long hanging down from the lower part of the crown, but drop off, as soon as their physiological function is fulfilled, leaving the naked stem slightly but closely ringed by the leaf-scars. (Fig. 151.)

One photograph which I have seen shows the crown invaded by an epiphytic *Cereus* which having first rooted itself in the rubbish accumulated at the base of the leaves which also readily catch and retain the rain water in their axils, has grown into a large and very dense mass of long dependent tail-like stems. I have observed a very similar occurrence in a photograph of a *Sabal*, communicated to me by Prof. Trelease, which I have doubtfully referred to *C. rosei* (see Webbia l. c., p. 85); in the mass among other epiphytes there appear to be also a *cactaceous* plant. In the back-ground of the same picture may be seen several individuals of apparently the same *Sabal*, having their long trunks terminated by only a tuft of the central and youngest leaves,

the others having evidently been cut away, to be employed in thatching houses, etc., or perhaps in the manufacture of hats.

Prof. Baker's photographs were taken in the savannahs of the western part of the island, where this *Sabal* seems to be a common plant (n. 857 of the dry specimens). Baker's n. 2308 from Batabano, Prov. of the Habana, and Wright's n. 3970 belong to this species.

S. parviflora grows also at Nueva Gerona in the Isla de Pinos, near the southwest coast of Cuba, according to Curtiss n. 484.

Figure 152. Sabal florida. a, portion of a flowering branchlet; b, flower during the anthesis; c, longitudinal section of a flower. From Combs No. 292.

Sabal florida Becc. in Webbia di U. Martelli, II, 46; **S. umbraculiferum** (non Mart.) Combs in Trans. Ac. Sc. St. Louis, VII (1897), 471.

It has been said by Mr. N. L. Britton in the review of my paper on the "Palme Americane" (Torreya, VIII (1908), 238) that *S. florida* differs but slightly from *S. palmetto;* but from this latter it is at once distinguishable by its terete (not angular) flower-bearing branchlets, and longer and narrower flowers. The specimens upon which the species was established were collected by Rob. Combs (n. 292) at Cienegnita, Prov. of Santa Clara, district of Cienfuegos, were common in poor soil, have a portion of the spadix in flower, the fruit is wanting, and nothing is known of the aspect and general dimensions of the plant. (Fig. 152.)

Sabal yapa Wright, Pl. Cubenses n. 3971 (nomen nudum); Sauvalle Fl. Cubana 152; G. Maza, Nociones, etc. (1903), 51; Becc. in Webbia di U. Mart., II, 64. **S. mexicana** (non Mart.) Gaum. Pl. Yucat. exic., n. 317. **Corypha maritima** Humb. et Bonpl. Nov. Gen. et Spec. pl. I, 298?

It is easily distinguishable from the other two Cuban species by its leaves, which are unequally and twice divided, several primary divisions being three-costulate and divided again into two unicostulate acuminate segments having

deeply bifid apices. It is also characterized by the relatively large, obovoid flowers, having a round top when in bud, and by the fruit being somewhat bent or slightly resupinate at its base.

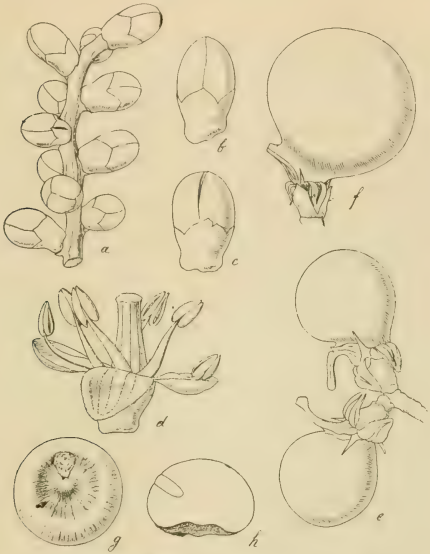


Figure 153. Sabal yapa. a, summit of a flowering branchlet; b, c, full grown unopened flowers; d, flower during the anthesis; e, young fruits; f, mature fruit; g, seed as seen from the raphal side; h, seed longitudinally cut through the embryo. Fig. e from a specimen collected in Cuba by Ramon de la Sagra; all the other figures from Wright No. 3971.

It was collected in Cuba by Ramon de la Sagra in 1829 (n. 222), and it has been found again there more recently by Wright (n. 3971, precise locality not stated) and by Jose Torralbas at Batabano (n. 179) near the sea, in the southwest part of the island. It grows also in Yucatan, as I have identified it with *S. yapa* Gaumer's n. 317 of the "Plantæ Yucatanæ".

Torralbas gives it the vernacular names of "Palma de Guano," "Cana" and also "Miraguano", Sauvalle those of "Guano cana de monte", and "Chagareta".

Roselle (*Hibiscus sabdariffa* L.)

EUGENE SCHOFIELD HEATH
POMONA COLLEGE

Many plants were brought to the warmer parts of the United States more than a hundred years ago by the Catholic padres, and the colonists who followed in the wake of the cross have, in most cases, been slow to continue the spread of the cultivation of those plants. Some which were perennial, have withstood the changes of the years and are now horticultural landmarks, and it has remained for the present generation to realize the economic value of those plants and to extend their culture. Within very recent years has the olive been put on a paying basis in California; it is within the last four years that the avocado or ahuacate has been planted as an orchard fruit; the white sapote has not even yet been put out in acreage. Plants introduced even more recently are still in many cases, specimen plants; for example, the mango, which, to be sure, is out in acreage in southern Florida, the cherimoya, the Queensland nut, the Feijoa, the black sapote, and others still less common. These are all trees or somewhat tree-like.

Several years ago there was introduced into the United States the roselle, known botanically as *Hibiscus sabdariffa* L., of the family Malvaceæ, and a close relative of *Hibiscus esculentus* L. (okra), *Hibiscus sinensis* Hort. (the Chinese Hibiscus), *Gossypium* L. (cotton), *Althea* L., *Abutilon* Tourn. (the flowering maples), *Malva* L., and others. The plant was probably first introduced into the United States from Mexico or the West Indies although it is probably a native of the eastern continent where its cultivation is of long standing. It was probably first introduced into California from Australia. It does well in warm, rather dry climates. It is an annual and on account of its fruiting in a single season, it is a valuable plant in newly settled countries. The seed is usually planted in February and March, and in a single season the bushy plant may attain a height about equaling that of a man. The leaves vary from entire leaves on young plants to five-parted leaves on older and larger plants and to three parted leaves, in the axils of which the flowers are borne. The flowers are large and yellow with red centers. They last for only one day. Within three weeks after flowering the calyxes usually enlarge to a length of from one and a fourth inches to two inches and a width of three-fourths of an inch to one and a fourth inches. By this time the calyx is a bright, clear, red, pointed structure enveloping a round, hard, green seed pod and subtended by bright, clear, red bracts. This usually occurs in October and November.

While roselle has long been cultivated in parts of the far east as a fiber crop, the young stems, also, are used in making jelly, but the most common use of the plant is made of the reddened calyxes and bracts, from which a tart sauce is manufactured. By cutting off the basal end of the bracteate calyx far enough up to cut into the cavity of the calyx, one may very readily squeeze

out the green pod or fruit which is not edible, and may then have left only the edible calyx and its bracts. A very delicious jelly is frequently made from the calyxes and bracts and in so using them, it is not necessary to remove the green fruits from the calyxes prior to cooking, as they may be eliminated at the time the boiled material is strained to separate the juice from the pulp. The juice

*Figure 154. Plant of roselle (*Hibiscus sabdariffa* L.) much reduced.

is often combined with other juices in the manufacture of jelly. Quince juice is frequently combined with it.

Roselle sauce and roselle jelly have been likened to similar cranberry products and are sometimes substituted for them, but an admirer of the

*The two illustrations published herewith are reproduced through the permission and kindness of Mr. Jos. A. Arnold, Chief of the Division of Publications, U. S. Department of Agriculture.

Figure 155. Calyxes of roselle—the Victor variety—natural size, showing, also, the red bracts.

cranberry sees little like it in roselle. True, both are tart and both are bright, clear, red, but both, also, have distinctive flavors.

The National Standard Dispensatory (Hare, Caspari, and Rusby, 1905) says that roselle "is sour from the presence of tartaric and malic (or oxalic?) acids" on which account it is used in hospitals in Mexico as a refrigerant as well as for its mucilage. The root is said to contain saponin.

The commercial use of roselle in southern California is still very limited, most of the product being raised in private gardens for private use. It is usually to be found in a few of the fruit stores in small quantities in its season. One firm in Los Angeles used a small quantity of it a few years ago in certain bakery products, as a jelly filling, but has been unable to buy it in sufficient quantities since. The Luzon Pineapple Plantation Company of Cabanatuan, Nueva Ecija, P. I., is planning to plant about twenty acres to roselle next year and expects to market it as sauce.

Roselle is of the easiest culture. It likes a hot, dry climate best but needs occasional irrigating. A long growing season is essential in order to bring the calyxes to proper size. Irrigation, if too frequent, delays maturity, but an abundance of water is said to heighten the red color of the calyxes. A loose deep soil is probably best for it. P. J. Wester, of the U. S. Department of Agriculture, in Farmers' Bulletin 307, advocates the use of commercial fertilizers rather than stable manures for roselle.

The plant has not received the popularity it deserves and when the people once become acquainted with it, surely it will increase in favor and possibly supplant some of the cheap imitation jelly products now on the markets.

The Small City Park as a Great Asset

RALPH D. CORNELL
POMONA COLLEGE

In the growth of cities, the past tendency has generally been to develop the commercial, the industrial and the residential districts. During this growth no effort has been made in behalf of the common people to beautify the streets uniformly, to provide for parks or to acquire and hold municipal squares or tracts of land for landscape improvement at such a time as the growth and wealth of the city would warrant the initial expenditure and subsequent upkeep. Blind practicality is apt to come first in the mind of the American of today, and the future welfare of the community and the betterment of humanity are overlooked in the attempt to excel commercially, industrially, or in population.

The task of properly providing breathing space and places of retreat from the noise and dirt and confusion of a large city is a vital problem. The provision of public parks for public use becomes a live question. Green grass and trees, flowers, fresh air, and sunshine are all absolutely essential for the health and happiness of the human race. It has truthfully been said that wretchedness and squalor breed crime; that beauty and cleanliness of surroundings inspire worthy thoughts and deeds and tend toward the elimination of things evil. The matter of city parks thus becomes an all important city problem and should be carefully weighed and considered in all city planning. Too much attention cannot be given this subject, and its importance is so often borne in upon the city relatively late in its growth, when it becomes necessary to condemn, or acquire by private purchase at high figure, lands for such public use. California has ever been inclined to profit from the experience of others, but she is still embryonic in her development and can realize with difficulty, if at all, the enormity of her future growth and progress.

This one small phase of city growth and welfare applies less to the smaller towns and its importance is proportional to the size of the village; but it is to the suburban towns, to the valley and foothill municipalities that the writer wishes to call especial attention. Here, the mere smallness of the incorporate limits tends to discourage even the thought of such municipal thrift, and to conceal its true significance. The lack of funds prevents investment in an enterprise of unquestionable but often underestimated value for the future good of the community. The small number of residents argues that there is enough of the country with its health-giving freshness and purity and that it is wasted effort to attempt civic park improvement.

But it is their decided lack of size that argues most strongly, from the standpoint of future welfare, in favor of present consideration of, and action upon the question at hand. In this early stage of development, land can be acquired readily and cheaply, in the most desired locations, relative to the future growth of the city, and reserved for park development till such a time

Plate 156. Here, the appearance of spaciousness and distance is given by mass plantings with well proportioned vistas of open lawn. This view was taken in one small corner of a park comprising in all a single city block.

Plate 157. It is here difficult to imagine the truth, that this vista shows but one corner of a single city square. The effect is accomplished by proper balance in planting and grouping.

as conditions may warrant. Planting need not be done immediately, although such action would be ideal; but there should be an aim in all city planning to provide ample and sufficient park lands in all sections of growth, to serve for future beautification and uplift of those districts.

For many of the smaller towns a single city block affords ample provision for the immediate and near future needs of the people. This, if planted and cared for, will be a source of investment to the city to be considered as capital stock of interest bearing value, because of its influence in attracting outsiders to the community and because of the civic pride and enthusiasm which it instills into the hearts of those who have created and are supporting it. It will pay its own way from the start, if only as an advertisement.

Central Park, in Los Angeles, is an example of such a city block given over to park purposes in the infantile stage of growth of the city, when there seemed no great, pressing need of such a step. Because of the city's magnitude, the value of Central Park to the civic health and welfare cannot now be estimated. Were the park many times its present size and still of such easy access from the business district, it would have many times its present value. It probably has more pedestrian visitors per square foot of its area than any other two or three of the city's abundant park reservations, excepting the Plaza. Its greatest good comes from the fact that it is restful to the tired eye of the passing worker, from the fact that it is of easy access to those who need its cheering influence, and from the mere fact that it affords a change from the glare and noise of the bustling city.

The larger parks, located in the outskirts of the city, are inaccessible and therefore of least value to those who would derive the greatest benefit from their use, as it is the person who lives on the pavement and has nothing to draw him out, or who has not the means to take an occasional outside holiday, who is in the greatest need of that influence created only by nature's green out-of-doors. The above cites one instance in which a relatively small town reserved a city block near the center of its business district, for park purposes and the future welfare of the community.

The Plaza in Los Angeles is another instance of a small city square doing a great good, and is situated in a district where it can be most enjoyed by those in the greatest need. The fact that Central Park and the Plaza are the most populous parks in Los Angeles, speaks well for their location and for the public service which they render.

Again citing the instance of the small town—we have proceeded to so advanced a stage that it is a small town indeed, that does not have ordinances controlling the play of children in the streets. Even though there be no such ordinances, streets are manifestly unfit for playgrounds. Every child should have access to spacious grounds for play, and every ideal city should provide such privileges. Where a municipality has only one or two small parks, they should not be given over entirely to this one phase of recreation, but they might have sections where young America could run and play, could enjoy the shade of real trees and become acquainted with flowers. Play under such conditions is natural, as nature intended, and is to be highly encouraged.

Plate 158. So restful and refreshing a retreat as this might readily be made a feature in the smallest of city parks.

Plate 159. An artistic and harmonious grouping of palms which affords a tropical effect for one corner of the public square.

In most instances where playgrounds have been established in California, and these instances are many, the grounds and apparatus are situated in the glaring sunlight with never a tree nor a leaf to freshen the view and break the monotony. It would be decidedly practical and very desirable to locate these playgrounds among trees and surround them by plantings of shrubbery and flowers; making of them not only a group of mechanical devices for the physical growth of the child, but also a garden for aid in its mental growth. The twofold utility of play and beauty might be furnished the child, as the plantings would afford secluded place for play and would have a pleasing influence both upon the children within and the passersby without.

A city square may be handled in either of two ways, as regards its planting plan. It may be treated in a decidedly formal manner, or it may be planted as simply and naturally as possible. Such a public square is the inevitable spot for the location of statues and fountains, and quite properly so, but it may also be planted with masses of shrubbery and trees arranged in rather an informal style. Wherever possible, the more natural methods of grouping and planting are to be preferred to the strictly formal style.

On the other hand, the public square may be laid out with a view to the pleasure which it will give to those passing by, without; or it may be arranged with the idea of affording pleasure to him who may pass through on his way to or from work, or who may tarry for a moment of relaxation. A combination of the two above schemes is undoubtedly that which should be most sought for in planning the park.

When designed as a park to be viewed from without, the planting is massed and executed with the sole idea of producing a pleasing picture when seen as a whole, with little attention given to the impression of pleasure or comfort from within the square. On the other hand, when the block is to be given over to public use, the methods of procedure, with reference to planting, are much modified. The designer then attempts to combine utility as a park, with attractiveness as a picture. Trees are planted in groups, to form dense shade under which seats and benches may be placed, or they are planted in rows along the walks and paths, for a similar reason. Shrubs and low growing plants are used to soften outlines, to blend and harmonize larger group plantings, and to create a more easy and natural effect in arrangement.

The paths and walks should be given easy and graceful curves but should form quite direct means of crossing the square. Aimless, winding walks lose their charm because of the attending bewilderment to one traversing them, and are a source of disgust to him who wishes to cross the grounds on his way to or from work.

Simplicity in landscaping should always be observed. It is doubtless unneedful to speak of the beauty of lawns and of the added attraction that well kept stretches of lawn always afford. Equally needless should it be to discourage the use of the already fast disappearing flower bed as an ornament in the center of a lawn, where it is highly out of place and detracts rather than adds to the pleasurable effect.

Plate 160. The shaded walk here invites rest and repose and is a welcome relief from the glare of the city streets.

Plate 161. The sunlit open, with the cool shade beyond, beckons, and invites the weary to restful relaxation.

The whole purpose of the designer should be to afford the greatest pleasure and benefit to the public, by giving ample shade, copious seating facilities, direct paths, and at the same time to afford pleasing vistas in miniature, with harmonious grouping and blending of shrubs as a means to the end of effective planting. The matter of creating a sky line and of exclusion, from the outside, of the city sights and noises, is not to be considered greatly because of the small area of parking space and the close proximity of outside influences.

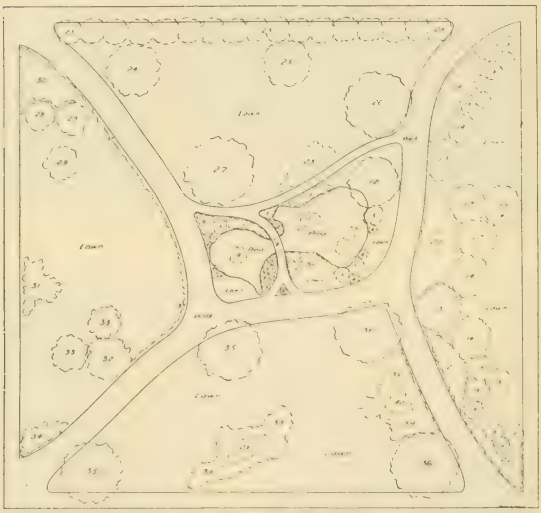


Plate No. 162

PLANTING LIST FOR PLATE No. 162. (The Plan showing the Lake)

A, Drinking fountain; B, foot bridge; 1, *Arundinaria falcata*; 2, *Andropogon citratus*; 3, *Betula alba*; 4, *Gynerium jubatum*; 5, *Maytenus boaria*; 6, *Colocasia antiquorum*; 7, *Bambusa aurea*; 8, *Dendrocalamus latiflorus*; 9, *Cyperus papyrus*; 10, *Nymphaea odorata*; 11, *Nelumbo nucifera*; 12, *Salix babylonica*; 13, *Phoenix canariensis*; 14, *Phoenix reclinata*; 15, *Erythea edulis*; 16, *Erythea armata*; 17, *Cocos plumosa*; 18, *Cocos crinospatha*; 19, Cacti (in variety); 20, Cycads (in variety); 21, Aloes (in variety); 22, Agaves (in variety); 23, *Cupressus macrocarpa*; 24, *Pinus canariensis*; 25, *Libocedrus decurrens*; 26, *Araucaria bidwilli*; 27, *Cedrus deodara*; 28, *Hakea suaveolens*; 29, *Olea europea*; 30, *Feijoa sellowiana*; 31, *Choisya ternata*; 32, *Acacia baileyana*; 33, *Acacia pendula*; 34, *Acacia verticillata*; 35, *Eucalyptus amygdalina*; 36, *Eucalyptus viminalis*; 37, *Heliotropium peruvianum*; 38, *Grevillea thelemanniana*; 39, *Melaleuca hypericifolia*; 40, *Hakea laurina*.

In the accompanying line cuts, Plate 162 is an original sketch showing one possible treatment for a city park of one block. The upper side of the plan represents the west exposure of the park; the Monterey Cypress thus is used to form a break from the prevailing winds while the grouping of palms on the right will give protection from the occasional north winds of our winter seasons. The treatment here is that which will give a pleasing effect from without, while still maintaining something of the spaciousness and seclusion that gives to a park its greatest charm. With the exception of the two sides above mentioned, no attempt has been made to shut the park away from outside sights and influences. Water, whether natural or artificial, is always an added

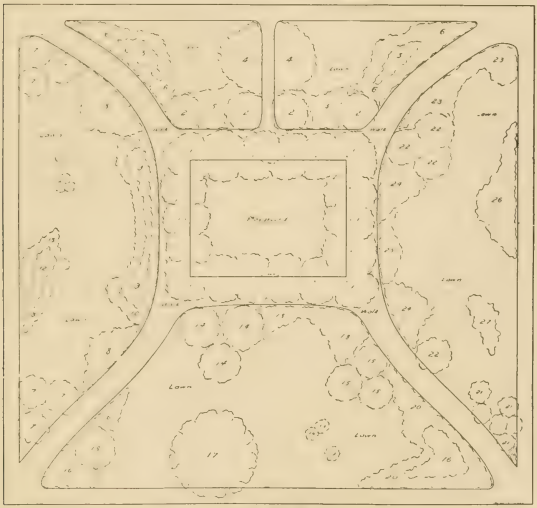


Plate No. 163

PLANTING LIST FOR PLATE No. 163. (Plan with Playground)

1, *Eucalyptus viminalis;* 2, *Acacia latifolia;* 3, *Spartium junceum;* 4, *Tecoma stans;* 5, *Hypericum floribunda;* 6, *Genista florida;* 7, *Ceratonia siliqua;* 8, *Pittosporum eugenioides;* 9, *Euonymous japonica;* 10, *Coprosma baueri;* 11, *Raphiolepis ovata;* 12, *Carissa grandiflora;* 13, *Carissa arduina;* 14, *Sterculia acerifolia;* 15, *Eucalyptus ficifolia;* 16, *Melaleuca hypericifolia;* 17, *Ficus macrophylla;* 18, *Grevillea thelemanniana;* 19, *Eugenia myrtifolia;* 20, *Erica carnea;* 21, *Prunus integrifolia;* 22, *Cinnamomum camphora;* 23, *Romneya coulteri;* 24, *Eleagnus refleza;* 25, *Choisya ternata;* 26, *Hakea elliptica;* 27, *Diosma ericoides.*

attraction to a planting, and can be very readily and tastefully worked into the smallest of parks with slight expenditure.

Plate 163 represents a type of treatment in which the dominant idea is that of affording shade and greenery for the playground, with shaded and attractive approaches leading to it; and at the same time of affording a pleasing view from the streets without. This treatment is rather more formal than that of the preceding plan, but is unavoidably so because of the necessary shape and size of the playground and because of its location in the center of the park. Were this reservation made in one corner of the block, it would allow greater, unbroken park space and make possible a less formal scheme of planting. Sufficient shade is here available for copious seating arrangements so that the park as a whole might be made into a decidedly utilitarian project.

Each of the accompanying line cuts represents a type of treatment that might well be carried out in the park of minimum dimensions. Specific cases, where distinctive problems arise and where special difficulties need to be overcome, require individual treatment that will meet the requirements of the locality and should be handled in a way to acquire the best results from the material at hand and to take best advantage of any natural assets such as contour, water facilities, and established trees.

Every small town should be able to boast of its public square, tastefully planted to trees and shrubs. Every undeveloped city should establish and maintain park spaces for the future, and thus avoid crime and squalor and sometimes, possibly even death that comes as a result of overcrowding in which insufficient opportunity is afforded to the laboring classes for indulgence in and enjoyment of fresh air, verdure and sunshine. If we make of our towns models, while young, they will continue to be models, when old, and will be free from much of the wretchedness and disease and crime of the overgrown metropolis. Let small city parks do their part in accomplishing this end.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume III FEBRUARY 1913 Number 1

The Palms Indigenous to Cuba III.*

ODOARDO BECCARI
FLORENCE, ITALY

ACOELORHAPHE H. Wendl.

H. Wendl. in Bot. Zeit. (1879), 148; Benth. et Hook. f. Gen. pl. III, 882; Becc. in Webbia di U. Mart. II (1907), 107. **Paurotis** O. F. Cook in Mem. Torrey bot. Club. XII, 21; Britton in Torreya, VIII (1908), 239.

The generic name of *Acoelorhaphe* was proposed by H. Wendland in a paper published in the volume for 1879 (p. 147) of the Botanische Zeitung and entitled: "Die habituellen Merkmale der Palmen mit faecherformigen Blatt." Here the genus is sufficiently well defined by the peculiarities of the leaves; furthermore the etymology of the name itself clearly points out the most prominent characteristic by which it is distinguishable from the allied genera, viz., the seed devoid of any intrusion of the raphe into the mass of the albumen. For these reasons I can in no wise agree with Prof. Britton that the generic name of *Acoelorhaphe* must give way to that of *Paurotis* O. F. Cook in Mem. Tor. Bot. Club, XII (1902), 21.

I did not mention the genus *Paurotis* in my monograph of the American *Coryphea* because at the time of its publication I had not had an opportunity of seeing Mr. Cook's paper, in which that genus is described. However, I feel inclined to follow Mr. Britton's opinion in this respect, namely, that *Paurotis androsana* Cook and *Acoelorhaphe wrightii* really represent but one species. I still remain uncertain, however, whether *A. arborescens* should be considered a distinct species or only a variety of *A. wrightii*. It is certain that *A. wrightii* is a common palm, distributed over a large area, presumably because its small fruits, although covered by a slightly pulpy pericarp, are probably coveted by birds, by whose aid its seeds are speedily dispersed.

Acoelorhaphe wrightii Wendl. in Herb. Berol. ex Becc. in Webbia II (1907), 109. **Copernicia wrightii** Gris. et Wendl. in Gris. Pl. Cub. 220; Sauv. Fl. Cub. n. 2367. **Paurotis wrightii** Britton in Torreya, VIII (1908), 239 (ex parte?).

This beautiful palm, in its general appearance, is quite unlike any other palm, chiefly by reason of its long spadices, which spring straight above the

*This is the third and concluding instalment of Professor Beccari's monograph. The others appeared in Vol. II, Nos. 2 and 4.

crown of the leaves. This palm grows in tufts of several stems of unequal age, but I do not know whether these are produced by off-shoots springing from the base of the older stems, or whether they are independent plants developed from the innumerable seeds, which drop around the mother plants. The stem is rather slender, erect and straight and possibly would remain for a very long time, perhaps for its life time, clothed by the dead leaves, if these were not cut away by man or burnt off by the fires of the savannahs, where this palm grows; in every case the trunk remains covered entirely and permanently down to the very base with the stumps of petiole bases arranged in gentle spirals.

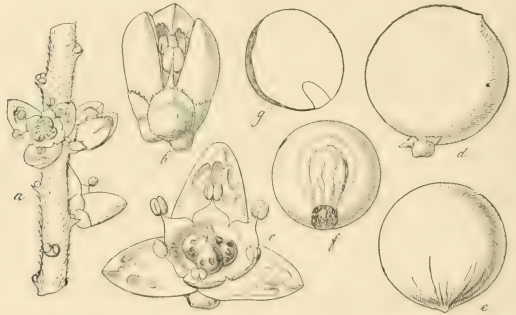


Figure 154. Acoelorhaphe wrightii. a, portion of a flowering branchlet; b, full grown unopened flower; c, flower during the anthesis; d, fruit; e, kernel; f, seed as seen from the raphal side; g, seed cut longitudinally through the embryo. a, b, and c, from a specimen collected by Combs at Cieneguita; d, e, and f, from a plant cultivated at Buitenzorg, Java.

A special feature of *Acoelorhaphe* is the long spadices, which spring straight upwards above the crown of leaves. Each is decomposed into several rather distantly superposed branches or partial panicles, crowded, at first, with innumerable and very small flowers and afterwards with small round fruits.

The type specimens of *A. wrightii* are those of the "Plantæ Cubenses Wrightianæ" n. 3207.

From plants growing at Herradura, in the Province of Pinar del Rio, were taken the specimens distributed under n. 4208.

A. wrightii, very slightly changed in its characters, grows, also, in Honduras, and at Nueva Gerona in the small island, Isla de Pinos. Of this latter, I made the variety Novo geronensis (Webbia l. c. p. 113). It is probably not specifically distinct from the plant of Cuba or the *Acoelorhaphe*

from White Water Bay in Florida, of which I have spoken in Webbia p. 117, and which I had considered as different from *A. arborescens*. It remains, also, doubtful whether *A. arborescens* of Florida should be considered specifically distinct from or only as a geographical form of the type plant of Cuba, and, also, whether *Paurotis androsana* of the Bahamas (of which I have seen no specimens) agrees more with the plant of Cuba or with that of Florida. (Figure 154).

Figure 155. Copernicia hospita. a, the summit of a flowering branchlet; b, c, flower-buds; d, open flower as seen from above; e, longitudinal section of a flower; f, seed, side view; g, the same seed cut longitudinally through the embryo. a, b, c, d, from Wright No. 3216; f, g, from Combs No. 334.

COPERNICIA Mart.

Hist. nat. Palm. III, 242, t. 49, 50 (excl. t. 50 A, I-IV), et Palm. Orbign. 41, t. 1, f. 3 et t. 94; Benth. et Hook. f. Gen. pl. III, 927 (excl. Chrysophila); Becc. in Webbia di U. Mart., II (1907), 140.

The species of this genus indigenous to Cuba belong, without exception, to the section *Copernicioipsis*, or to those of which the spadix has all its divisions, to the smallest flower-bearing branchlets, sheathed in spathes or spathels more or less tubular in their basal parts.

A. Ultimate divisions of the spadix slender, more or less scorpioid.
  a. Spathels, bracts and flowers hairy.
    b. Flower buds ovoid, rather acute, divisions of the corolla equilaterally triangular. *C. hospita*
    bb. Flower buds long-pointed, divisions of the corolla elongate-triangular, acuminate. *C. curtissii*
  aa. Spathels, bracts and flowers glabrous. *C. glabrescens*

Figure 156. Copernicia curtissii. a, the summit of a flowering branchlet; b, flower; c, longitudinal section of a flower; d, fruit; e, seed, as seen from the raphal side; f, side view of the same seed; g, seed cut longitudinally through the embryo. From Curtiss No. 435.

AA. Ultimate divisions of the spadix covered with closely packed flowers, amentiform on the whole, softly and densely hairy and as thick as a man's little finger. *C. macroglossa*

Copernicia hospita Mart. Hist. nat. Palm., II, 243, t. 50 A, f. 5, et III, 319; Cris. Pl. Cub. 220; Sauv. Fl. Cub. n. 2365; R. Combs in Trans. Ac. Sc. St. Louis, VIII, 17, (1897), 471; Becc. in Webbia di C. Mart. II (1907), 172.

This palm is well represented in the herbaria by complete specimens, but nothing is known of its general aspect and dimensions. The *leaves* have the blades glaucescent on both surfaces and covered by a thin coating of waxy matter, which in the dried specimens is easily detachable in very small, narrow flakes. The elongate *spadices* are much branched; the branchlets, and ultimate divisions and flower-bearing spikelets are curved, scorpioid and hairy. The flowers are ovoid, rather acute, and covered with appressed silky hairs externally. The *fruit* is spherical, 13-15 mm. in diameter, (Figure 155).

Specimens of this have been gathered in Cuba by several collectors. At Calicita in the District of Cienfuegos, Prov. of Santa Clara, *R. Combs* n. 334; at Herradura, Prov. Pinar del Rio, *Van Herman*, n. 850; *Wright* Pl. Cub. n. 3216.

Copernicia curtissii Becc. in Webbia di U. Mart., II (1907), 176.

It differs from *C. hospita* by its flowers, which gradually narrow to a sharp point and have the divisions of the corolla elongate-triangular (not deltoid) and acuminate; other minor differences are mentioned in Webbia l. c. (Figure 156).

It is no doubt a second species, which substitutes in the small Isla de Pinos for the more diffuse *C. hospita* of the larger island. It was established on Curtiss n. 435, collected at Nueva Gerona.

Copernicia glabrescens Wendl., nomen in Wright, Pl. Cub. n. 3968; Sauv. Fl. Cub. n. 2366; Becc. in Webbia di U. Mart., II (1907), 170.

In general appearance greatly resembles *C. hospita* and *C. curtissii*, but it is easily distinguishable from both by its smaller, hairless flowers, and by all the different parts of the spadix (branchlets, spathes and axes of the spikelets) being, also, glabrous.

The fruit of this species is as yet unknown. (Figure 157).

It grows at Herradura, Prov. Pinar del Rio (*Van Hermann* n. 904); *Wright* Pl. Cub. n. 3968, without precise locality.

Copernicia macroglossa Wendl. in Kerch. Palm. 241; Sauv. Fl. Cub. n. 2368; Becc. in Webbia di U. Mart., II (1907), 177. **Copernicia sp.** Combs in Trans. Ac. Sc. St. Louis, VIII (1897), 471.

Figure 158 gives a very fair idea of this fine and curious palm, very conspicuous for its large, glaucous and robust leaves, whose blades are borne upon short and robust petioles armed at the edges with large spines resembling the teeth of a coarse saw. The trunk is short, stout and solitary; presumably it would remain permanently covered by its dead leaves, if these were not cut off by man or burnt off by the not infrequent fires in the savannahs, where this palm seems largely disseminated and where it forms the most conspicuous object among coarse grasses and weeds, by the mass of its beautiful glaucous leaves. The trunk remains therefore covered by projecting stumps, the remains of the bases of the dead leaves.

Several spadices shoot out from among the leaves; are somewhat longer than the latter, are very peculiar on account of their innumerable flowers

agglomerated around the ultimate branchlets and hidden by densely hairy bracts, so as to form small woolly catkin-like spikes, as thick as a man's little finger. (Figure 159).

Specimens collected from plants at Guanabacoa, near Havana, bear the n. 2928.

Figure 157. Copernicia glabrescens. a, the summit of a flowering branchlet; b, open flower as seen from above; c, flower; d, longitudinal section of the above flower. From Wright No. 3968.

It has been collected, also, at Calicita, District of Cienfuegos, Prov. of Santa Clara (Combs n. 335), and distributed by Wright under the n. 3969. Ramon de la Sagra first discovered this palm in Cuba in the year 1829 (Herb. De Cand.) and he gives the vernacular name "Yapa". *C. macroglossa* is, according to Prof. Baker, the so-called "Yata" palm.

Figure 158. Copernicia macroglossa.

PRITCHARDIA

Seem. et Wendl. in Bonpl. IX, 260; X, 197, 310, t. 15; Benth. et Hook. f. Gen. pl. III, 928; Becc. Malesia, III, 286, et in Webbia di U. Mart., II (1907), 200. **Colpothrinax** Gris. et Wendl. in Bot. Zeit. 1897, 147.

Pritchardia wrightii Becc. in Webbia di U. Mart., II (1907), 203. **Colpothrinax wrightii** Gris. et Wendl. in Kerch. Palm. 241; Sauv. Fl. Cub. n. 2382.

This palm is sufficiently well known to botanists from the specimens preserved in the principal herbaria of Europe and America, but certainly very few people are acquainted with the most singular aspect it assumes in

Figure 159. Copernicia macroglossa. a, flower; b, corolla laid open; c, calyx; d, bracts; f, growing ovaries; g, the same ovary cut longitudinally; h, fruit; i, longitudinal section of the fruit with all parts in situ; k, seed, raphal side view; l, seed cut longitudinally through the embryo. The figures of the fruit from Combs No. 335; all the others from Wright No. 3969.

its native country as is shown in the beautiful photographs taken by Prof. Baker at Herradura near Havana. (Plates 160 and 161). Here the stems of this *Pritchardia* look like enormous bottles tapering into a long neck and rising from among the grasses. These palms are scattered about in the savannahs, where they are associated with *Byrsonima crassifolia*, an unbecoming crooked tree of the family *Malpighiaceæ*, and with another, also conspicuous, spindle-stemmed palm, the *Oreodoxa regia*.

I have already given a detailed account of the principal characters presented by the different organs of *Pritchardia wrightii* in the "Palmæ Americanæ" (Webbia l. c.), and I have now nothing to add to what I have already said there, except some considerations in respect to the singular conformation of its stem. (Figure 162).

Figure 160. Pritchardia wrightii.

Figure 161. Pritchardia wrightii.

The stem of *P. wrightii* is always single and rises quite straight from the soil for a meter or two; at first it is cylindrical and of a uniform diameter of about 30 cm., then it begins gradually to increase in thickness till it attains about twice the diameter of its basal part; afterwards, the swelling of the stem begins to decrease in the same ratio, becoming cylindrical again, but thinner than below the swelling; it continues to lengthen for several meters more, till the trunk attains a total length of 10-12 m. From this manner of growing it follows that in middle aged individuals the spindle-like swelling is more or less mesial, but in plants that have attained a considerable height the enlarged part appears approximate to the base and imparts a very strange and quite unique appearance to this palm.

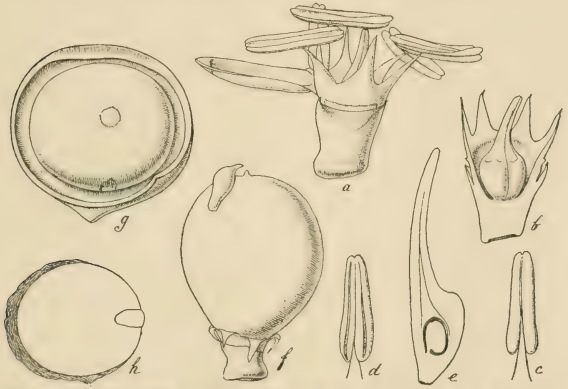


Figure 162. Pritchardia wrightii. a, flower during the anthesis, only one of the segments remains attached to the tube of the corolla; b, longitudinal section of a flower (the segments of the corolla and the anthers are wanting) showing the ovarium entire; c, anther from the dorsal side; d, anther from the inner side; e, one of the carpels cut longitudinally; f, young fruit bearing at its apex the remains of a sterile carpel; g, section of the kernel showing the entire seed inside; h, section of a seed along the line of the raphe and dividing the embryo in the middle. The flowers from Curtiss No. 364, Isla de Pinos; the fruit from another source.

On its lower part the trunk of *P. wrightii* appears (at least from what I can judge from the photograph) covered by a cracked, corky bark, as is the case with *Jubaea, Livistona, Washingtonia,* and numerous other palms; but the swelling and the entire trunk above it have a smooth surface, more or loss distinctly ringed by leaf-scars, but otherwise quite clean to the very base of the crown, for the older and functionless leaves do not remain long hanging down, but soon drop off.

HEMITHRINAX

Hook. f. in Benth. et Hook. f. Gen. pl. III, 930; Becc. in Webbia di U. Mart. II (1907) 243.

Hemithrinax compacta Hook. f. l. c. 931; Becc. l. c. 245. **Thrithrinax compacta** Gris. et. Wendl. ex Gris. Cat. Cub. 221; Sauv. Fl. Cub. n. 2381.

I cannot describe the general aspect of this palm, as there is no picture of it. I have little doubt, however, that it must be very like a *Thrinax*, as the genus *Hemithrinax* differs only and very slightly from *Thrinax* of the Sectio *Typhlothrinax*, in that the stamens have the anthers borne on very short filaments, which, during the anthesis, are reverted or curved downwards, so that the anthers show externally the side that normally is turned towards the interior: the dehiscence of the anther-cells, therefore, appears to be extrorse, while that of the *Thrinax* takes place in the usual way or is introrse. The anther-cells are separated by an unusually broad connective. (Figure 163).

Figure 163. Hemithrinax compacta. a, portion of a flowering branchlet; b, c, flowers during the anthesis; d, e, anthers, dorsal side; f, anther, inner side, becoming external by reversion of the filament during the anthesis; g, flower from which the anthers have been removed; h, longitudinal section of an ovary; i, fruit; k, seed; l, longitudinal section of a seed through the embryo. From Wright No. 3222.

This palm is known only from Wright's n. 3222, and the precise locality in which the specimens were gathered is uncertain. Sauvalle gives for it the vernacular name "Palma Caule".

THRINAX

Linn. f. ex Swartz, Prod. veg. Ind. occ. (1788) 57, et Fl. Ind. occ. I, 614, t. 13; Sargent in Bot. Gaz. XXVII (1899), 83; Becc. in Webbia di U. Mart. II (1907), 247.

Sectio A. *Euthrinax* (*porothrinax* Wendl.)

Seed with albumen traversed from base to top by the raphal intrusion of the integument.

1. Flowers and fruits borne on a long pedicel.

   Fruit 5 mm. or slightly more in diameter. Leaves green on both surfaces, but on the lower sprinkled with very small, light-colored, elongate dots. *T. wendlandiana*

2. Flowers and fruits sessile.

   Leaves slightly glaucescent, or slightly silvery and obsoletely dotted on the lower surface. Fruits 4 mm. in diameter. *T. drudei*

Sectio B. *Typhlothrinax*.

Seed with albumen more or less penetrated by a basal intrusion of the integument, but not traversed throughout from base to top.*

Flowers and fruits sessile. Leaves slightly silvery-white on the lower surface, and, also, closely sprinkled with very small, elliptical, ferrugineous dots. *T. punctulata*

Thrinax wendlandiana Becc. in Webbia di U. Mart. II (1907), 265. **T. martii** Gris. et Wendl. Pl. Cub. 221 (nomen ex Sauv. Fl. Cub. n. 2373. **T. parviflora** (non Sw.?) Sauv. Fl. Cub. l. c. **Porothrinax pumilio** Wendl. ex Sauv. Fl. Cub. l. c.

This is a graceful palm which has the trunk elongate, cylindrical, rather slender, usually slightly bent at the base or ascendent, rising from an enlarged subbulbous base, which is entirely formed of fine rootlets very closely packed together. The surface of the stem is obscurely marked by annular rings and is somewhat rimose. The crown is not very dense and the leaves have their blades borne by slender petioles, which have their bases immersed in a mass of pure white and soft cottony tomentum; the old leaves are suddenly reflexed and hang for a certain time below the living crown.

T. wendlandiana is easily distinguishable among the Cuban species of the genus by its long pedicellate flowers and fruits. The *fruit* is 5 mm. in diameter, and has the surface more or less granulose when dry; the *seed* is traversed from base to top by the intrusion of the tegument. The *flowers* have six stamens with very slender filiform filaments, and long, very narrow, linear anthers.

The *leaf* has the blade green on both surfaces, slightly paler on the lower, which is sprinkled with very small scales, in the form of light-colored linear-elliptical dots.

Perhaps *T. wendlandiana* is not sufficiently distinct, as a species, from the true *T. parviflora* growing in Jamaica; and, probably, it is only a geographical form of this latter species.

It differs from *T. parviflora* mainly by its stamens having the filaments longer and narrower, and by the narrower and longer anthers. Besides, the

*This character is not so important as might be at first supposed, for I have found it rather variable, as in *T. harrisiana*, where occasionally the seed is not completely traversed by the intrusion.

fruits of *T. wendlandiana* seem to be smaller than those of *T. parviflora*, but of the first I have seen none sufficiently developed for exact comparison. In *T. parviflora* the filaments are a little longer than the teeth of the perianth, and have lanceolate bases; and the proportion between the breadth and length of the anthers (in fully expanded flowers) is 1:6-7; while in *T. wendlandiana* the filaments are linear from their bases, considerably longer than the teeth of the perianth, and the proportion between the breadth and the length of the anthers is 1:10. (Figure 164).

The photo was taken at Santa Catalina, Prov. Pinar del Rio, and in that locality were gathered the specimens bearing the n. 3464. To this species belong Wright n. 3219, and n. 3928 of van Hermann, collected near Havana.

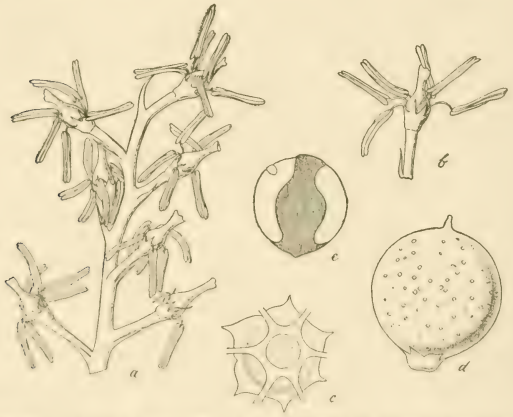


Figure 164. Thrinax wendlandiana. a, apical portion of a flowering branchlet; b, flower; c, fruiting perianth, out of which the fruit has been taken, seen from above, and showing the bases of the filaments; d, fruit; e, seed cut longitudinally through the embryo. From Wright No. 3219.

I consider as belonging to *T. Wendlandiana* some specimens collected by Gaumer in the Mugueres Island in the Bay of Honduras, and another from Gozumel Island, also, near the coast of Honduras. I have, also, just received (February, 1912) specimens of *T. wendlandiana*, which has been recently discovered at Madeira Hummock, near the extreme southern point of Florida, and, also, at Pumpkin Key, by a correspondent of Prof. Sargent.

Thrinax drudei Becc. in Webbia di U. Mart., II (1907), 269. **T. multiflora** (non Mart.) Wright, Pl. Cub. n. 3965.

The *leaves* are whitish or greyish on the lower surface, where they are, also, sprinkled with very small whitish-brown dots, not easily distinguishable without the assistance of a lens; the segments appear to be very closely longitudinally veined by numerous secondary nerves. The *spadices* are divided into several partial inflorescences, which are composed of slender, subulate, straight and rigid branchlets, which form all together rather loose ovoid or oblong panicles. The *flowers* and *fruits* are sessile on the branchlets.

The *fruits* are very small, and hardly attain 4 mm. in diam., but those seen by me are not perfectly mature, although sufficiently evolute to show the albumen completely perforated from base to top; and in this the plant would appear to be quite distinct from *T. punctulata* which it otherwise resembles in its straight, rigid, flower-bearing branchlets, and in its very small fruits. (Figure 165).

T. drudei is known to me only from Wright's specimen n. 3965, which presents no thoroughly mature fruits and no flowers.

Thrinax punctulata Becc. in Webbia di U. Mart., II (1907), 280.

Figure 165. Thrinax drudei. a, fruit with the perianth as seen from below; b, seed; c, seed cut longitudinally through the embryo. From Wright No. 3965.

As it appears in the photograph (Plate 166) taken on the precipitous limestone cliffs of the forest-clad Mount Guanajay, this is a very elegant palm, which attains about forty feet of height, and has a straight cylindrical stem, marked by the usual approximate ring-like scars, and is terminated by a rather well furnished and elongate crown of leaves. The *leaves* have rather enlarged, elongate, ascendent bases, from which the long and slender petioles, sustaining the elegant radiately divided blades, rise in graceful curves. The dead leaves do not remain long to cover the trunk, which, except at its summit, is naked and of the uniform diameter of 7-8 cm. throughout. The base of the trunk has the same system of rootlets as in *T. wendlandiana*. The leaves have the divisions whitish on their lower surfaces, where they are, moreover, more densely dotted than in the other species, with small, ferrugineous, elliptical scales, and have 10-12 very slender, secondary nerves on each side of the midrib. The primary branches or partial inflorescences form rather dense ovoidal panicles, composed of slender flower-bearing branchlets, of which the lower and larger are 7-8 cm. long. The *flowers* are unknown. The *fruits* are quite sessile and very small, barely attaining 4 mm. in diameter. The *seed* is only 2.5 mm. in diameter and has the intrusion of the integument broadly conical, reaching to about the center of the albumen. (Figure 167).

Figure 166. Thrinax punctulata.

This species is known only from the specimens distributed by Van Hermann under n. 4245, collected on the same Mt. Guanajay in the Province Pinar del Rio, where the photograph was taken. The specimen bears only fruits and the flowers remain unknown.

As I have already pointed out (see under *T. drudei*) there is much resemblance between *T. punctulata* and *T. drudei* in general appearance, and it is necessary to obtain better specimens with flowers of both to establish these species on more sure diagnostic characters. Probably *T. drudei* is from the east of Cuba, as most of Wright's plants are, and *T. punctulata* is its representative form in the west part of the island.

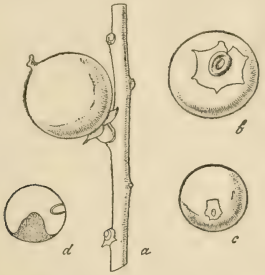


Figure 167. Thrinax punctulata. a, portion of a fruiting branchlet; b, fruit with the perianth as seen from behind; c, seed showing the hilum; d, seed cut longitudinally through the embryo. From Van Hermann No. 4745.

COCCOTHRINAX

Sargent in Bot. Gaz. XXVII (1899), 87; Becc. in Webbia di U. Mart., II (1907), 288. **Thrinax** (partim) auct. plur. **Thrincoma** O. F. Cook in Bull. Torrey Bot. Club, 1901, 539. **Tringhis** O. F. Cook l. c., 544.

A. Leaves of adult plants very deeply divided into a relatively few (25-30 at most) segments.

a. Leaves conspicuously silvery-white underneath, with very rigid radiating segments. Flowers more or less pedicellate. *C. miraguano*

aa. Leaves green on both surfaces. Flowers sessile. *C. rigida*

AA. Leaves having the blades entire in the center for at least the third part of the entire length, but usually more than that, and divided at the periphery into numerous (35-40) segments.

a. Leaves lustrous on the upper surface, and greyish or whitish on the lower.

b. Flowers with 12 stamens. Fruits more or less pedicellate on the lower part of the branchlets, almost sessile above. *C. martii*

bb. Flowers with 6-9 stamens. Fruits borne on a pedicel 3-5 mm. long. *C. acuminata*

aa. Leaves slightly ferrugineous (not silvery-white) on the lower surface, divisions strongly striately-veined on both surfaces. *C. crinita*

Coccothrinax miraguano Becc. in Webbia di U. Mart., II (1907), 295. **Thrinax? miraguano** Mart. Hist. nat. Palm. III, 320; Sauv. Fl. Cub. n. 2378.

This palm grows as isolated, scattered individuals in the plain at Cayamas in the Province of Santa Clara, apparently much deprived of its usual associates by the fires, which from time to time destroy the smaller vegetation of the savannahs. It is not a large palm, as it does not appear to surpass the height of 5-6 meters. The stem is cylindrical, probably not

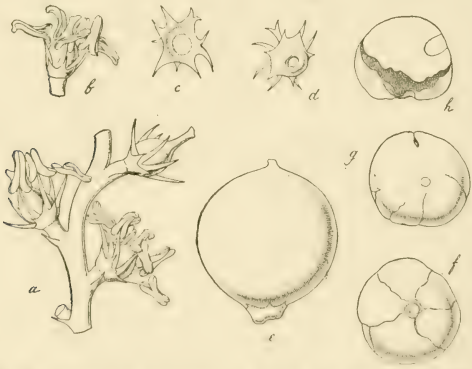


Figure 168. Coccothrinax miraguano. a, portion of a flowering branchlet (the flowers are pedicellate); b, flower; c, fruiting perianth, as seen from above, after the fruit has been removed; d, fruiting perianth, as seen from behind; e, fruit; f, seed seen from above; g, seed, lower surface, in the center is the hilum; h, seed cut longitudinally through the embryo. From Wright No. 3221.

more than 15 cm. in diameter; it is crowned by brilliant, stiff, silvery leaves, but is clothed at the same time, perhaps during many years, with the dead ones, or, at least, it remains covered by half burnt vaginas of the leaf-stalks, when the blade has happened to be destroyed by fire. With time these stumps, also, fall off, and the base of the trunk remains for a certain distance above the soil naked and marked by approximate ring-like scars.

The expanded *leaves* of the full grown plant are of a very stiff texture, orbicular, divided into 20-25 or even 30 radiating segments of a beautiful

silvery-white on their lower surfaces. The *flowers* are small, have 8-9 stamens and are more or less pedicellate. The *fruit* is spherical, 8-9 mm. in diameter; the *seed* is 6.5-7 mm. in diameter and is marked by 4-5 vertical folds. (Figure 168).

This is one of the most peculiar, and at the same time one of the better known palms of Cuba, where apparently it is rather widely distributed (see Webbiæ l. c.). It grows also in the Isla de Pinos according to the specimens distributed by Curtiss (n. 423), but these specimens differ slightly from those of the larger island in having almost sessile flowers. (Figure 169).

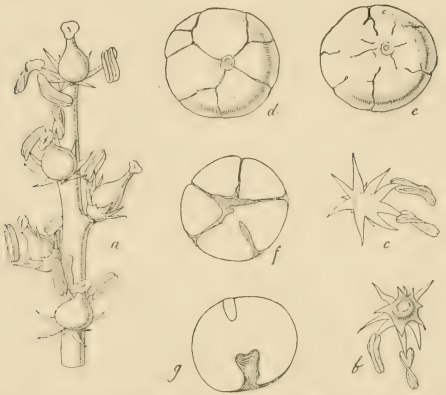


Figure 169. Coccothrinax miraguano (novo geronensis). a, portion of a flowering branchlet (the flowers are sessile); b, inner view of a flower, from which the ovary has been removed; c, flower seen from behind; d, seed, lower surface in the center is the hilum; e, seed, upper surface; f, seed, transverse section; g, longitudinal section of a seed through the embryo; in this section the albumen seems homogeneous, the cut not having severed any fold of the integument. From Curtiss No. 423.

Vernacular names: "Miraguano, Yuraguano, Guanichiche."

Coccothrinax rigida Becc. in Webbia di U. Mart., II, 299. **Thrinax rigida** Gris. et Wendl. in Gris. Cat. Pl. cub. 221; Sauv. Fl. Cub. n. 2377.

This is known only by the specimens distributed by Wright with n. 3220, probably collected in the east of the island.

It is evidently related to *C. miraguano*, but it is a smaller plant, the leaves have fewer, narrower, and less stiff divisions, and these are devoid of the beautiful silvery coating on the lower surface. The flowers are sessile; the fruits are unknown. (Figure 170).

Coccothrinax martii Becc. in Webbia di U. Mart., II (1907), 305. **Thrinax martii** Gris. et Wendl. in Gris. Cat. pl. Cub. 221 (partim?); Sauv. Fl. Cub. n. 2373 (partim?).

Collected only by Wright, probably in eastern end of the island, and distributed under n. 3219.

It is characterized by its *leaves* being rather deeply divided into numerous (about 38) segments, which are lustrous above and silvery-white underneath, by the *flowers* having 12 stamens, and by the *fruits* (7-8 mm. in diameter) borne on a pedicel 2 mm. long on the lower part of the branchlets, and sessile above; under the lens the surface of the fruit appears very finely punctulate-scabrid. (Figure 171).

Coccothrinax acuminata Sargent in Bot. Gaz., XXVII (1899), 89; Becc. in Webbia di U. Mart., II (1907), 313. **Thrinax acuminata** Gris. et Wendl. in Pl. Cub. Wrightianae n. 3966 (nomen in H. Kew.); Sauv. Fl. Cub. n. 2379; G. Maza, Nociones, etc. (1893), 51.

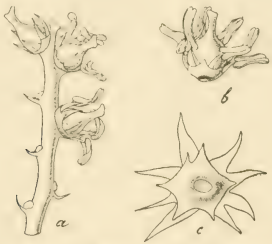


Figure 170. Coccothrinax rigida. a, upper end of a flowering branchlet; b, flower; c, perianth as seen from behind. From Wright No. 3220.

This is another of the palms discovered by Wright, probably in the east of Cuba; it has been distributed under the n. 3966. The specimens have no flowers, and bear fruits not thoroughly mature; these, however, are characteristic, as they are distinctly pediccllate (the pedicel is 3-5 mm. long) and not perfectly spherical, as in most species, but more or less distinctly globular-turbinate and apiculate, and have the surface finely and densely granulate. The leaves are silvery-white on the lower surface and are divided into about forty segments. Inside the fruiting perianth the remains of 6-9 stamens are distinguishable. (Figure 172).

Coccothrinax? crinita Becc. in Webbia di U. Mart., II (1907), 334. **Thrinax crinita** Gris. et Wendl. in Wright, Pl. Cub. n. 3967; Sauv. Fl. Cub. n. 2380.

I have doubtfully included this very imperfectly known palm in the genus *Coccothrinax*, as it has a general likeness to *C. argentea*. It differs,

however, from all the other Thrinax-like palms found in Cuba by its leaves, which are relatively large, divided into numerous segments (about 40) and not silvery underneath, but very faintly covered with a thin slightly rusty coating, which seems to vanish in the old leaves.

The specimens upon which the species is founded consist only of leaves and of portions of the fibrous net resting at the base of the petiole and composed of very fine brown filaments. This is perhaps another of the palms growing only in the east of the island.

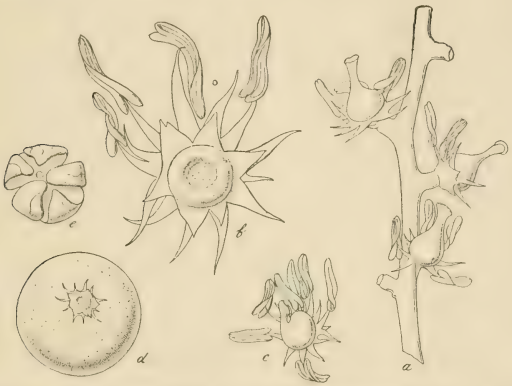


Figure 171. Coccothrinax martii. a, portion of a flowering branchlet; b, flower, front view; c, flower as seen from behind; d, fruit; e, seed from a not quite mature fruit. From Wright No. 3219.

NOTE ON STEM THICKENING IN PALMS

It is now a very well established fact that the stem of several palms increases considerably in diameter, especially in its basal part, and this increase is said to be caused by a secondary growth, which, while it chiefly takes place in the fundamental parenchymatous tissue, is, also, in a small measure, developed by the formation of new fibro-vascular bundles.* I think, however, that the abnormal increase in diameter, or bulging, of the woody cylinder of certain palms in their intermediate, or upper part, which results in fusiform or clavate shaped trunks, is of a somewhat different nature from the more common form of thickening, observed in numerous palms, especially in those with a cocoid trunk.

*Zodda: Sull'ispessimento dello stipite di alcune Palme, in "Malpighia" v. XVIII (1904), page 33.

Martius supposes that the peculiar structure of the fusiform or bulging trunks† may have originated in an increased number of leaves thrown out during a period of maximum vegetative activity of the plant, which subsequently and gradually decreased. This same explanation is accepted by Dr. J. W. Harshberger in his paper on the hour-glass stems of the Bermuda palmetto.‡ In this palm the stem frequently exhibits one or more waist-like constrictions, or hour-glass contractions, with interposed swellings, which are produced, according to this observer, by alternating periods of seasons favorable or prejudicial to the perfect growth of this palmetto. These periods are in direct correspondence with a larger or smaller crown of leaves, the larger diameters of the stem corresponding, of course, to the periods in which, as

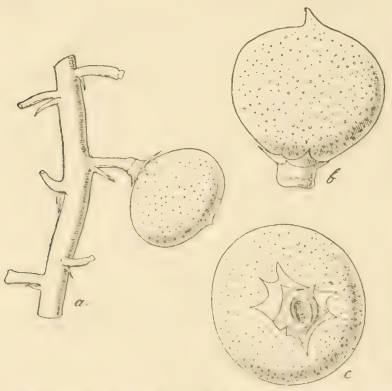


Figure 172. Coccothrinax acuminata. a, portion of a fruiting branchlet; b, fruit not thoroughly mature; c, the same fruit as seen from behind. From Wright No. 3966.

the more numerous leaves show, the vegetative forces are most active. The author adds, also, that "The increase is due to the expansion of the parenchymatous fundamental tissue, which separates the vascular bundles accompanied by an increase in the cell-cavity and by the increased thickening of the walls of the sclerenchymatous fibers which support the bundles."

If we take a special case of bulging, that for instance of *Pritchardia wrighti*, we may imagine that in youth the trunk for a certain time remains more or less cylindrical, probably on account of the uniform vegetative

†*Martius:* Hist. nat. Palm., v. III, page LXXXIV.
‡Proceedings of the Academy of Nat. Sc. of Philadelphia, 1905, page 701.

activity of its crown, but, when an increased production of leaves begins, it broadens gradually in its upper part, till the moment arrives at which the plant reaches and passes the maximum of its vegetative activity. The production of supernumerary leaves now gradually ceases, giving origin to the inverted phenomenon or the tapering of the trunk at its upper end. Such apparently is the process by which we may hold that the production of a fusiform or clavate trunk has been brought about. But the economic or utilitarian side of this contrivance consists, as I believe, in the building of a store house of reserve materials, to be utilized during the reproductive period of the plant, for it seems that the anomalous swelling decreases in size, when the plant begins to bear fruits. In this connection I have to observe that those palms with large and bulky trunks, as *Sagus, Jubaea, Washingtonia,* etc., have these of a soft pith-like texture in the interior, while their parenchymatous cells are filled with starch grains, especially in the period preceding the first emission of the spadices, that is, at the beginning of the reproductive period. We may, therefore, by analogy, suppose that the bulging of the trunk at a determinate period of the life of certain palms, may prove useful to them as magazines of reserve materials which accumulate there during the period of maximum vegetative activity of the plant, to supply the needful nutriment to the reproductive organs when the decrease in that activity shall set in.

The increase in diameter of the trunk in palms is certainly not a constant fact, for very many of them retain a trunk of unvarying thickness throughout their lifetime, as do those of an arundinaceous, calamoid or arecoid (cylindricus—Mohl.) type. But even where a general or local augmentation in thickness does take place, this is not always of the same nature; different causes must intervene both where there is a general increase throughout the entire trunk as in several palms of the cocoid type (*Jubaea, Washingtonia, Livistona,* etc.) or where only a bulbiform thickening takes place at the base (as in *Acantophoenix crinita, Latania commersonii, Hyophorbe commersonii,* etc.), or again where the increase is represented by a more or less pronounced partial bulging in the intermediate or upper part, as in *Iriartea ventricosa, Acrocomia fusiformis, Pritchardia wrightii, Hyphaene venticosa,* etc.

To better explain the difference between these different structures in the trunks of palms, I think that it will not be entirely useless to expound here, very briefly, my conception of the general structure of the trunk of a palm.

The primordial leaf of a palm, when fully developed and furnished at its base with a primordial root, produces from its axil a second leaf; this in its turn emits a second root which makes its way through the fundamental tissue of the corm-like base of the preceding or firstborn leaf, but externally and above the firstborn root. The progressive evolution of the entire plant is apparently a repetition of this phenomenon, from which it results that the more recently produced roots must be the more external, and that their

appearance must be in direct correspondence with the more internal, or last formed leaves.

According to these views we may suppose that in the vegetative cone of the trunk of a palm, the phenomena occurring in a primordial leaf are repeated as many times as there are leaves in the crown. The entire body of a palm should, therefore, be considered as a sympodium or an aggregate of several unities, each represented by one leaf furnished at its base with a vital node, from whence descend the fibro-vascular bundles, which ultimately end in corresponding roots.

The incipient fibro-vascular bundles descending from every newly formed leaf should, therefore, from the beginning, be considered as containing the elements of new roots and as corresponding to the first root issuing from the node of a primordial leaf. Such descending bundles, if they were not prevented by the continuous change of position of the leaves, as these gradually expand, would penetrate gradually and vertically the central part of the woody cylinder down to the roots; but as everybody knows, the new leaves are, during their expansion, gradually transported towards the periphery of the stem, and consequently the fibro-vascular bundles derived from the bases of these leaves are obliged to follow them, and to take the well-known course from the periphery towards the center of the woody cylinder, from whence they can freely descend throughout its entire length down to the base. Here, however, of necessity, the vascular bundles are forced to bend again towards the periphery, because they need to be organically connected in one way or another, with the roots. This connection, however, cannot be made with the old pre-existing roots, because these occupy the central part of the base of the trunk, and because every new emission of roots always takes place externally to and above the old ones.

Generally it is believed that the new roots originate quite independently of the vascular bundles of the central cylinder, but that a connection is established later between the bundles of the roots and those of the stem.* But my observations, however, confirm those of Meneghini†, who has demonstrated that in *Chamaerops humilis* "The fibro-vascular bundles of the roots are direct continuations of those descending from the leaves and more especially of those which being the last formed are peripheric;" and I will add that the point of emission of a new root is, in consequence, pre-established by the position of its corresponding leaf. To strengthen this opinion I would remark that, in cultivated palms, there is always a correlation between certain leaves and certain determinate roots, so that if a root be injured by disease, or is killed by other cause, the corresponding leaf also shows signs of decay, and vice-versa. It may, also, be observed that a new root can never originate in direct correspondence to an old or dead leaf.

*Drabble: On the Anatomy of the Roots of Palms, in Trans. Linn. Soc. London 2d Ser. VI (1901), Botany, page 143.

†Meneghini: Ricerche sulla struttura del caule delle piante Monocotiledoni (1836), page 101, tab. VII. 6.

This is proved by the fact that when a palm loses its central shoot no new roots make their appearance, although the more external leaves may remain alive and retain their functional activity for several years afterwards.

From what I have observed, the new emission of roots happens only when the newly formed leaves begin to expand. This exposition of the mode in which new roots in palms are emitted, is corroborated by what takes place when, for example, we desire, for horticultural purposes, to transplant a palm (a *Phoenix* or a *Cocos*, for instance). We are then obliged to cut away the greater part of its roots, and also the older, but not yet quite functionless, leaves. We can then see that the new roots make their way externally to and above the old ones, on the periphery and at the base of the trunk, as soon as the newly formed leaves begin to expand.

From all I have now said, it seems to me certain that a correlation exists between the emission of new leaves and that of new roots. This parallelism apparently exists, also, in the number, form, and disposition of the vascular bundles of the roots, and in the form, number, and disposition of the primary nerves in the primordial leaves. The existence, therefore, of an uninterrupted continuity between the vascular bundles descending from the leaves and the new roots, appears extremely probable; it is, indeed, an unavoidable consequence of the necessity of a physiological connection between the hypogean and the aerial system.

The result of this continuity of the vascular bundles descending from the new leaves down to the base of the trunk is that we find at every new vegetative period an increased number of newly formed vascular bundles; these must not, however, be regarded as elements of secondary growths, but as true primary formations striving to intercalate themselves among the pre-existing vascular elements. An interstitial augmentation of the number of vascular bundles thus takes place, which in the case of those palms whose stems are unable to distend their outer or cortical coatings (arecoid, arundinaceous, calamoid trunks) increase their internal solidity; while those trunks whose tissues are of a soft nature and which, on account of the loose structure of the peripherous parts of their woody cylinders, are susceptible of distension, (which is especially the case in palms of the cocoid type), will increase in girth. In this latter kind of trunks even the fundamental parenchymatous tissue may find room for cellular multiplication. If, therefore, in any transverse section of the lower and thickened part of a palm stem new, young, vascular bundles occur, I am inclined to suppose that this fact is not to be attributed to a neoformation process, but to an extension in length or to a division of the new bundles derived from the nearly expanded leaves in their tendency to produce new roots. Of these bundles, perhaps only a portion reaches the base of the trunk to produce bulbous enlargements and cause the emission of new roots there; other portions may be arrested at different levels and contribute only to the solidity of the woody cylinder; or, at times and under certain circumstances, they may force their way

outward, appearing as adventitious roots; for it seems that the entire mass of the vascular bundles of recent formation is endowed with a latent potentiality of producing adventitious roots, whenever a portion of it is able, under favorable conditions of ambient, to pierce an opening through the external cylinder. This is what happens in those palms which produce large masses of adventitious roots in the epigeous parts of their trunks, for instance, in *Thrinax wendlandiana* and, more especially, in *Gaussia princeps* among the Cuban palms, and, also, among the palms cultivated in our country, viz., *Washingtonia*, *Phoenix dactylifera*, etc., when they meet with suitable conditions of temperature and moisture.

From the observations made above I am led to conclude, that the bulging of the stem in palms is due to the same ordinary processes which cause the lengthening of the vegetative cone in the normally developed stems, and it apparently depends, not upon a secondary growth of the already formed elements, but, while it is partly due to the greater number of fibro-vascular bundles produced (and, also, perhaps, to the greater diameter of their elements), yet, in a still greater measure, it is the effect of the greater diameter of the cells composing the fundamental tissue and of the larger intercellular spaces, the increased diameter of the cells being obviously caused by the accumulation in their interiors of a large quantity of starch grains, or of nutritive fluids, all of which are due to the increased vegetative activity of the plant, in the moment that precedes the beginning of the reproductive period.

This was, also, the opinion of Martius, who, speaking of the fusiform stem of *Iriartea ventricosa* (vol. III p. LXXXV), writes that the swelling is produced, not so much by an increase in thickness of the wood, but principally by the more abundant and more lax parenchymatous tissue. While greatly regretting that he had been unable to analyse the trunk of the said palm, when he had the opportunity of doing so, he reproduces a manuscript note of Plumier on the swollen trunk of *Euterpe? vinifera* (*Pseudophoenix vinifera* Becc.). Of this palm Plumier says that at the point where the upper portion of the inflated part begins to taper (corresponding to the period in which the plant is about to produce fruit for the first time), the tissues of the inflated part are soft and pulpy and contain a great quantity of a very sweet juice, from which, by fermentation, a kind of wine is made. The pith-like parenchymatous substance of the interior of the swelling must be very soft and the juice it contains very abundant, as this latter is obtained simply by squeezing the parenchymatous tissue between the hands, after it has been reduced to a paste by repeated beatings with a pestle,*

*Of *Iriartea ventricosa* Mart. writes, (v. III, page LXXXV): Quaenam sit in illa parte tumida ligni compages, qui fibrarum decursus et quae ad materiem cellulosam ratio, examinare, dum in palmae patria commorabar, quod valde dolco, neglexi, attamen mihi persuadeo, in illo caudicis fuso materiem ligni nec frequentiorem, nec spissiorem esse, immo parenchyma, fibris percursum, interiora laxius quam in reliquo caudice replere.

And of the *Euterpe? vinifera* (*Pseudophoenix*) it is said (l. c. p. LXXXVI.): Constat vero haec singularis caudicis struma e substantia omogenea, medullosa, fructu Melonis

When the swelling of a fusiform trunk has attained a certain diameter, it probably remains unchanged for the lifetime of the plant. I can, however, produce no personal observations on the subject. Certainly the same cannot be asserted of the bulbous bases of some arecoid trunks, as those mentioned above, nor even of the entire lower portions of others of the cocoid type, for in both cases an increase in diameter has been unquestionably ascertained by numerous observers. I have myself perceived by careful measurements the increase in bulk of the stem of a *Jubaea spectabilis* cultivated in my garden near Florence. This I measured in the year 1906 on behalf of Prof. Strasburger* and ascertained that it, at that time, was 3 m. 30 cm. in girth at about 10 cm. above the ground, whereas, in August, 1911, it had increased to 3 m. 71 cm.

In such a kind of trunk the augmentation in diameter may be correctly attributed, in a great measure at least, to a secondary merismatic multiplication of the fundamental tissue; but still more, I think, to the interlocation between the pre-existing elements, of a large number of fibro-vascular bundles descending from the vegetative cone at every emission of new leaves.

---

spissiore et fluido scatet saccharino, quod sapore cum dulcissimo liquore Coci nuciferae immo interdum cum succo expresso Arundinis sacchariferae potest comparari, atque a venitoribus pro extinguenda siti bibitur.

*Ueber die Verdickungsweise der Staemme von Palmen, in "Jahrbüch. für wiss. Bot." XLIII. 4, page 607.

The Propagation of the Date

RALPH D. CORNELL*
POMONA COLLEGE

The propagation of the edible date in the arid, southwestern regions of the United States is an industry that has but recently been put upon a commercial basis, although the United States Department of Agriculture made its first importation of date palms about twenty-five years ago. The area in which this palm will thrive and mature fruit is necessarily limited in this country because of the intense heat that is required for the several months preceding and during the ripening of the crop; so that the industry seems now to be confined to a few localities such as the Colorado Desert region, the Chuckawalla country and Palo Verde mesa, the Imperial Valley, Yuma, Arizona, and regions about Phoenix and the Salt River Valley. The results obtained from seedlings and imported plants tested in these regions have been so satisfactory and highly profitable that private companies and individuals have gone into the rearing and growing of dates on a sufficiently large scale to eliminate doubt as to the future magnitude of the industry. They are already beginning to propagate their own plants. And this phase of date growing will naturally increase as the orchards from which propagating material can be drawn, increase.

If propagation is attempted from seeds, about one-half of the seedling plants will be male palms and practically valueless; for the male palm does not bear fruit. And since one male palm will suffice to pollinate the flower clusters of an acre of female plants, it becomes necessary to destroy about forty-nine out of every fifty of these male plants that have required months of care and attention before their sex could be determined. This method is, therefore, obviously wasteful and expensive. On the other hand, of the possible forty or fifty female palms that will be obtainable from a hundred seedlings, there may be but three or four, and sometimes only one, that is of a quality sufficiently fine to make it worthy of consideration for commercial purposes. (Opinion varies so that no definite number can be given. Some claim that as high as ten per cent. of the females will produce good fruit). All of the remaining female plants bear fruit that is of a quality inferior to this and of as many different characteristics as there are different seedlings from which to pick fruit, since the seedling date sports very decidedly, this tendency varying in degree somewhat with the variety of seeds planted. It is thus seen that from a possible hundred seeds, but a very few palms bear desirable fruit; and these would very probably be so different in flavor, color, size and other characteristics that they could not be standardized as com-

*Mr. Cornell has spent some considerable time among the date orchards of Southern California during the last two years.

mercial varieties unless there were some way in which a variety could be perpetuated. This way is evidently not from growing seedlings.

Palm off-shoots are small suckers which grow from the sides and around the bases of the larger palms; and it is from these off-shoots that all standard varieties of commercial dates are grown, since they will root and grow into palms that bear fruit identical with that of the parent plants. The Arabs have known this fact for generations and have thus established many distinct varieties that can be found in abundance in the old date growing regions

Plate 173. This illustrates the way in which the off-shoots are unloaded at the nursery, after being dipped and hauled from the station. They sometimes lie for two days before being planted.

around the Persian Gulf and the Algerian deserts. They think of growing date palms in no other way and will carry off-shoots of a choice variety on camel back, for a journey of days, to plant them in their own gardens. And, thus, the problem of establishing and maintaining standard commercial varieties has been solved most satisfactorily.

As the date palm is not indigenous to America, the question of introducing and establishing it here, presented a rather difficult problem, since it was necessary to import these off-shoots from half way around the globe. The United States Department of Agriculture was the first to bring in

plants; and the impetus gained from their small importation of a quarter century ago, has been such that one private concern, alone, imported 15,000 off-shoots, in the summer of 1913, for commercial planting in and about the Colorado Desert. These shoots, which weigh anywhere from ten to fifty pounds, are severed from the parent tree by means of heavy chisels made especially for the purpose. After painting the severed butt-ends of the shoots, their tops are trimmed and the whole plant is wrapped and sewed in a covering of palm fiber or burlap, preparatory to shipment. They are

Plate 154. There are about 15,000 off-shoots in this one nursery field in which the planters are still at work. The young palms are leaned slightly toward the prevailing wind, because it is thought that they will thus grow straighter; the rows are four feet apart, with the plants three feet apart in the rows.

frequently packed in boxes to facilitate handling on their long journey during which they must be kept sufficiently moist to prevent excessive drying, but not so damp as to encourage mould or rot. At the end of their journey, the Department of Agriculture requires that they be immersed for two different periods of fifteen minutes each in an insecticide of given formula that is a guaranteed "kill-all-but-the-plant." They must then be planted in nursery form in an isolated place at least one thousand feet from any other date palms where they have to serve a year's sentence of quarantine

before being admitted as bona fide citizens to the date world of the United States.

After being thus rudely torn from the side of the parent plant to make a ninety day journey over land and sea, at the end of which they are given a half hour bath in a solution strong enough to kill all animal parasites, these young date palms are hauled to their new home where the rooting process is to take place. Here, they are unloaded on the ground and lie in the burning heat, sometimes for two days, before they are set in the ground and watered. This exposure to the dry air and intense heat tends to dry them thoroughly and stop any fungous growth that may have started.

Plate 175. This photograph shows a bed of seed flats ready to receive the seeds; the boxes have been sunk in the ground and filled with soil; after planting and covering, the bed can be easily flooded with water from the ditch. A fair idea may here be gained of the barrenness of the desert. The darkest clumps are mesquite; the low growing, lighter colored clumps are salt bush, grease-wood, etc.

as well as to reduce the danger to the palms of rotting after they have been planted. Thus far, the shoots seem to have been indifferent to much harsh treatment; but after planting in the nursery rows, they demand skilled and systematic attention. They must be kept continually moist and are generally watered every other day for the first six weeks. After this time, the fre-

quency of the irrigations may be gradually diminished as the young shoots establish themselves in their new home; but the plants should never be allowed to approach a state of dryness. During the first few weeks that the roots are starting, it is considered fatal to the life of the palm to disturb its position in the least, an idea that has grown to be almost a superstition with some who claim that the slightest jar to the plant during this period will injure the new roots and kill the palm. Undoubtedly the rooting process is slow and laborious, it being a not uncommon thing for an off-shoot to lie dormant for a whole year before evidencing any signs of life, though most of the shoots will be well rooted at the end of eight or nine months. The percentage which lives varies with the variety of the date, with the condition of the plants upon their arrival, and with the treatment which they receive in the nursery; but the rooting has been generally successful.

Although the commercial date must be propagated from off-shoots, as previously stated, it sometimes becomes desirable to grow seedlings for a windbreak, or from which to experiment on new varieties. It is because of the tendency of the date to sport that new fruits can be obtained from seedlings, very few of which may be far superior to their parent kind. Although it is generally a slow and unsatisfactory method of establishing an orchard, to plant seedlings and go through the long and expensive process of selection and elimination, if one is so fortunate as to draw a prize plant out of a possible hundred or thousand seedlings, he may be well repaid for his pains; for all new varieties must originate from seedlings. This choice seedling can be encouraged to produce off-shoots and by their propagation, one could in time establish this new variety to the ultimate good of the date industry.

And so it is that a word on the growing of the seedling may not be amiss. It is generally thought that while the date does not come true to seed, there is, nevertheless, a slight tendency of the offspring to resemble somewhat its parent type; so that, in planting seeds, it seems wise to select them from choice fruits. These are generally soaked in warm water for about a week before being planted, to hasten their germination. They may then be planted in seed flats or in the open ground according to the convenience at the time. However, planting in boxes makes easier the subsequent handling. In any event, soil should not be used, that contains sufficient alkali to injure an ordinary field crop. The seeds should be covered to a depth of one or two inches at a distance of three or four inches apart, after which it is largely a matter of keeping them watered. When a few inches high, they are set out in rows where they can be cared for till old enough to show their sex, if they are desired for selective purposes, and should be given enough room not to crowd for at least four years, when the sex of most of the plants will have been determined.

When off-shoots have become well rooted, or when these seedlings have thus been sorted, they are ready for orchard form, where about fifty palms

are set to the acre. If well favored by sufficient irrigation, cultivation and intense heat, these young plants will begin to bear in three or four years from the seed or off-shoot. By ten years, they will attain a maximum capacity of fruiting which will endure throughout the life of the palm. The date is known to grow and bear fruit for at least a century. When it has thus become established in orchards of the southwest, offshoots will be produced in sufficient abundance to forego the necessity of importing them from abroad; and their propagation will be made possible at much less cost and with a greater degree of certainty than now exists.

Imported Varieties of the Avocado for California

K. A. RYERSON
ASSOCIATE EDITOR UNIVERSITY OF CALIFORNIA JOURNAL OF AGRICULTURE

In the development of so promising a commercial enterprise as the culture of the avocado has proved to be, naturally the question of the most suitable varieties is paramount. During the past two or three years, there have appeared many varieties, originating locally, some of which lack little of being classed as ideal commercial fruits. However, no matter how well adapted to the demands of the market these varieties may be, there is still room for improvement. The season in which avocados may be secured at a reasonable cost needs to be lengthened; we now have varieties that give us fruits almost continuously throughout the year but the quantity is limited.

The extension of avocado growing into the cooler parts of California depends on the securing of the hardiest types, and this requires the careful exploration of the native avocado districts of the world. But little has been done in this line as yet; we do not know what possibilities lie undiscovered in the highlands of Mexico, Central and South America. Mexico has received the most attention so far. The grower, in the end, will not be satisfied until he has the very best that the world affords. The first steps in this direction have been made for the most part by private concerns, the government having attempted little thus far. The first explorations have greatly increased our number of commercial varieties and have added much to the length of the season in which avocados will be able to be obtained reasonably and plentifully.

It is a recognized fact that the fruit intended to be placed on the eastern market must be of the thick skinned type in order to withstand shipment without great loss. Also, in order to compete on an equal footing with the Florida avocado, this type will have to be adhered to. We can not expect a profitable return unless the California product is equal to or better than that of its competitor. The thin skinned type is admirably suited to the local market and to growing for home use, since it is, as a rule, very prolific and somewhat hardier than many of the larger thick skinned fruits in our list at present. Nevertheless, it is not reasonable to conclude that if a choice variety is somewhat more tender than a more inferior variety, the latter should be planted in preference. If it is profitable to protect an orange grove from the ravages of the cold, how much more reasonable to protect fruit yielding far greater returns than the orange.

It is to the highlands of Mexico, Central and South America that we must look for new varieties of the avocado, that will be suitable to our climatic conditions. Because a variety is rated as a Mexican or Central or

Plate 176. Fruit of Ideal, about seven-eighths natural size.

South American variety, it does not follow that it will be adapted to our conditions. All conditions of climate are found in these regions, from those of the torrid tropical lowlands to those at the altitude of perpetual snows. The regions from which the greater majority of our new introductions have come are the highlands of Mexico ranging from about four thousand five hundred to eight thousand feet in altitude; notably Atlixco, 7000 feet; Queretaro, 6000 feet; Guanajuato, 6800 feet; and Guadalajara, 5400 feet. The climatic conditions of these regions are strikingly similar to those of much of California; in parts the rainfall is even less than that which most of Southern California enjoys. Much, then, is to be expected from fruits of these districts. Practically the whole of Central and South America remains to be explored. Travelers report types and varieties of the avocado at the present time unknown to our horticulture. No one can accurately predict the extent to which this fruit may be cultivated in the future.

The importation of the avocado from these regions south of the United States has been successfully done by three parties in Southern California,—Mr. D. E. Clower of Monrovia, Mr. A. R. Rideout of Whittier, and the West India Gardens of Altadena.

One hears and reads of the so-called imported varieties without knowing just what has been accomplished along that line, and it is in order to show the extent of this work, that the following list is presented. It gives as completely as possible those varieties that have been imported up to the present time. Wherever possible the complete pomological description is given, but this is manifestly impossible in all cases, as the material is not available. When all have fruited in this country, there may be some variation from the parent type. However, all conditions are so similar to those of its native home that it is doubtful if there will be much deviation from type or from the time of the fruiting season.

The following three varieties were introduced by D. E. Clower of Monrovia, California, from Mexico and South America. He has also several several other varieties under trial.

IDEAL

Description: Form, pyriform; size, large; dimensions, length, seven, diameter, four and one-half inches; weight, one and one-half pounds; surface, rough; color, green; skin, thick and hard, separating readily from the flesh; flesh, rich, creamy yellow; texture, smooth and oily; fibre, none; flavor, very fine; quality, first; seed, small, tight in cavity; season, March to June. Mexico.

TWO POUND GREEN

Description: Form, pyriform; size, very large; dimensions, length seven and one-half, diameter four and three-quarters inches; weight, two pounds; surface, rough, color, green; skin, thick and tough, separating readily from

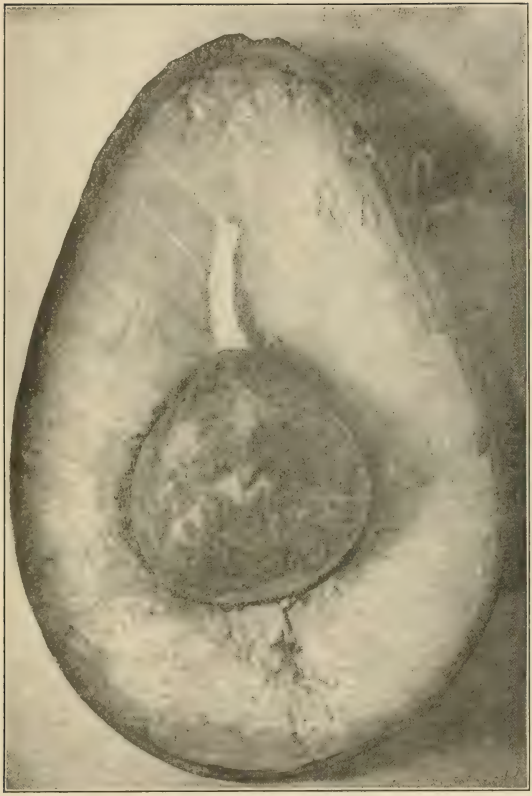


Plate 177. Ideal, in section, about natural size.

the flesh; flesh, creamy yellow; texture, very oily; fibre, none; flavor, very rich and pleasant; quality, first; seed, small, tight in cavity; season, March to June. Mexico.

CHILI

Description: Form, pyriform; size, medium; weight, twelve ounces; color, green; skin, thick and tough, separating readily from the flesh; flesh, creamy yellow; texture, smooth and very oily; fibre, none; flavor, rich and nutty; quality, very good; seed, small, tight in cavity; season, June in Chili.

The parent tree of this variety is growing at an altitude in Chili where twelve inches of snow is said to fall, showing it to be one of the hardiest of varieties. The leaves possess the anise odor peculiar almost exclusively to the small, thin-skinned Mexican varieties. The commercial qualities of this fruit are said to be such that it commands a price on the Chilean market that would be considered very high even in this country, despite the fact that the common small, thin-skinned varieties are selling on the same market at three for five cents. The season in Chili is just the reverse of ours so that it will probably ripen its fruit in June in this country.

WEST INDIA GARDENS IMPORTATIONS

NUMBER SEVEN

One of the trees that proved to be most hardy in the California freeze of 1912-13 is that known as Number Seven, it being untouched even in its exposed position in the open ground with a temperature of 16 degrees. It was introduced from San Sebastian, Queretaro, Mexico, at an altitude of between five and six thousand feet. The fruit is of an excellent quality.

Description: Form, oval; size, medium to large; dimensions, length six, diameter, two and one-half inches; weight, three quarters to one pound; skin, thick, separating readily from the flesh; color, black; flesh, yellow shading to green near the skin; flavor and quality, very good; seed, medium, tight in cavity; season, March at San Sebastian, Queretaro.

NUMBER NINE

Description: Form, oval to pyriform; size, large; color, black; skin, thick, separating from the flesh; flesh, medium yellow, tinged greenish near the skin; seed, medium, tight in cavity; season, July and August at Canada, Queretaro.

QUERETARO (NUMBER ELEVEN)

The Queretaro is one of the very prolific varieties, and the young trees now growing here seem to flourish well.

Description: Form, oval; size, medium large; dimensions, length, five, diameter, three inches; surface, rough; color, black; skin, thick and tough; flesh, medium yellow, separating readily from the skin; flavor, extra fine;

quality, good to very good; seed, medium small, tight in cavity; season, August to October at Canada, Queretaro.

PUEBLA (NUMBER THIRTEEN)

Description: Form, pyriform, not necked; size, medium; dimensions, length, four, diameter, three inches; surface, smooth; color, purple; skin, thick and tough, separating readily from the flesh; flesh, yellow, greenish towards skin; flavor, fine; quality, good; seed, small, tight in cavity; season, September and October at Atlixco, Mexico.

Plate 178. No. 7. Budded trees 1 year 10 months from bud; 1 year old stock.

NUMBER FIFTEEN

Young trees of this variety are doing well at the present time in California, and it promises to be one of the best medium sized fruits in a commercial way. It is of good shape for packing and shipping and of extra fine quality.

Description: Form, oval; size, medium; dimensions, length, four, diameter, three inches; surface, somewhat rough; color, green; skin, thick, separating readily from the flesh; flesh, yellow, smooth and buttery; flavor, rich; quality, very good; seed, small, tight in cavity; season, October and November at Atlixco, Puebla.

REDONDO (NUMBER SIXTEEN)

Several round varieties have been imported among the other types and these have a special advantage over the others in that they are able to be packed better and grade much more uniformly. When shipped for any great distance they are much less liable to injury in transit. The tree from which this variety was derived is over a hundred years old and is forty feet high.

Description: Form, round; size, medium; dimensions, length, three and one-quarter, diameter, three and one-quarter inches; weight, three-quarters of a pound; apex, slightly flattened; base, round; surface, somewhat rough;

Plate 179. Redondo No. 16.

color, dark green with fairly numerous, small, yellowish, irregular, subcutaneous dots; skin, very thick, hard and tough, separating readily from the flesh; flesh, cream color, shading to greenish near the skin; texture, smooth and buttery; fibre, none; flavor, rich, nutty and delicious; quality, very excellent; seed, small, round-conical, tight in cavity; season, November and December at Atlixco, Puebla.

CALIFORNIA TRAPP (NUMBER SEVENTEEN)

The variety known as the Trapp is the leading Florida fruit in the eastern markets. It is an extremely popular fruit and comes at a season when it can command the fanciest prices, i. e., from October first to January

first. In California, however, this variety has failed to thrive thus far, though many attempts have been made to establish it here. From Atlixco now comes a variety that very closely resembles the Florida fruit in size, shape, and season and it is of the first quality. It is well suited for extensive orchard plantings and is well adapted to the climate of this state.

Description: Form, roundish, slightly oblique, cross section, very slightly scalloped; size, large; dimensions, length, five and one-quarter, width, four and three-quarters inches; weight, twenty-two ounces; base, very slightly tapering, insertion slightly one-sided; apex, flattened slightly; stem, stout;

Plate 180. California Trapp No. 17.

surface, fairly smooth; color, medium green with few, small to large irregular raised russet dots; skin, very thick, tough and hard, separating readily from the flesh; flesh, cream color, greenish near skin; texture, smooth and buttery; fibre, almost none; flavor, mild, rich and nutty; quality, first; seed, medium, oblate, tight in cavity; season, December and January at Atlixco, Puebla.

Number Eighteen

Description: Form, long pyriform, sometimes slightly curved; size, medium large; dimensions, length, six and one-quarter, diameter, three and one-half inches; weight, about one pound; base, tapering, rather narrow; apex, rounded; stem, stout; surface, somewhat rough; color, purple with

fairly numerous, rounded, small, yellowish dots; skin, thick, tough and hard, separating readily from the flesh; flesh, light cream, tinged green near skin; texture, smooth; fibre, none; flavor, mild, nutty and delicious; quality, first; seed, medium, slender, conical, tight in cavity; season, December and January at Atlixco, Puebla.

NUMBER NINETEEN

Few varieties can equal this one in the unusually high proportion of meat to seed. It ranks among the very first of all discovered thus far. It

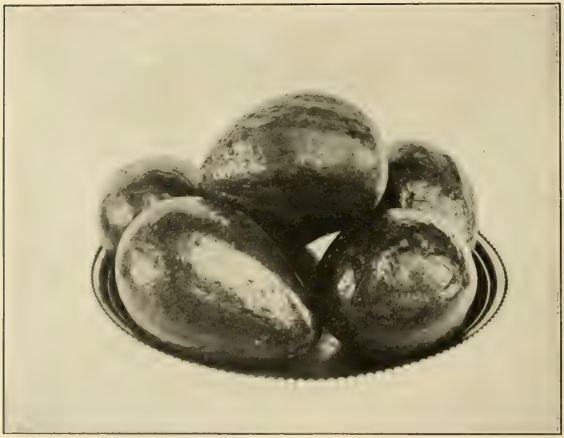


Plate 181. No. 19.

is very large and has a tough skin, making it a good shipper. It should prove a prime favorite for hotel trade, one fruit making a salad sufficient for six persons.

Description: Form, slender pyriform; size, very large; dimensions, length, seven, diameter, four and one-quarter inches; weight, one and three-quarters pounds; base, broad, tapering somewhat; apex, round; surface, undulating, slightly rough; color, dark green with a number of medium sized, irregular, indented russet dots; skin, thick, hard and tough, separating readily from the flesh; flesh, cream, slightly greenish near skin; texture, smooth and buttery; fibre, none; flavor, rich, buttery and delicious; quality, extra good; seed, small to medium, conical, tight in cavity; season, January at Atlixco, Queretaro.

NUMBER TWENTY-FIVE

Description: Form, round to pyriform; size, medium to large; dimensions, length, five, diameter, three and one-half inches; weight, one pound; apex, slightly oblique, flattened; stem, stout; surface, slightly roughened; color, yellowish green with numerous, medium sized, irregular, subcutaneous, yellowish dots; skin, thick, tough and hard, separating readily from the flesh; flesh, cream, tinged green near skin; texture, very smooth and buttery; fibre, none; flavor, mild and very pleasant; quality, excellent; seed, very small, conical, tight in cavity; season, January at Atlixco, Queretaro.

NUMBER TWENTY-EIGHT

Description: Form, round-oval to pyriform; size, large; dimensions, length, six and one-half, diameter, four inches; weight, one and one-quarter pounds; base, tapering somewhat; apex, slightly flattened or depressed; stem, stout; surface, rough, slightly undulating; color, deep dark green with numerous small to medium sized irregular, subcutaneous, greenish yellow dots; skin, thick, hard and tough, separating readily from the flesh; flesh, deep creamy yellow, turning green near skin; texture, smooth and buttery; fibre, none; flavor, rich, mild and nutty; quality, very good; seed, small, conical, and tight in cavity; season, November to January at Atlixco, Puebla.

ATLIXCO (NUMBER TWENTY-NINE)

Description: Form, oblong to obliquely pyriform; size, medium large; dimensions, length, five, diameter, three and three-quarters inches; weight, one pound; base, oblique, flattened slightly; stem cavity, very shallow, narrow, flaring and plaited; apex, flattened, slightly concave; stem, stout; surface, slightly rough; color, greenish purple with numerous, small, irregular, subcutaneous yellowish dots; skin, thick, tough, not brittle, separating fairly readily from the flesh; flesh, light cream, tinged green near skin; texture, smooth, fine; fiber, none; flavor, good, nutty, mild; quality, good; seed, medium to large, oblong-conical, tight in cavity; season, December at Atlixco, Puebla.

NUMBER THIRTY-TWO

Description: Form, slender pyriform; size, medium large; dimensions, length, six and one-half, diameter, three and one-half inches; weight, one and one-eighth pounds; base, tapering, broadly blunt; stem cavity, medium in width, shallow, flaring and creased with russet markings; apex, slightly flattened, point indistinguishable; stem, stout; surface, undulating, slightly warty in spots; color, glossy green with small, irregular, raised, russet dots often in patches; skin, very thick, hard and granular, separating readily from the flesh; flesh, deep cream, greenish near skin; texture, smooth; fiber, none; flavor, mild and pleasant; quality, good; seed, very small, conical, tight in cavity; season, December to February at Atlixco, Puebla.

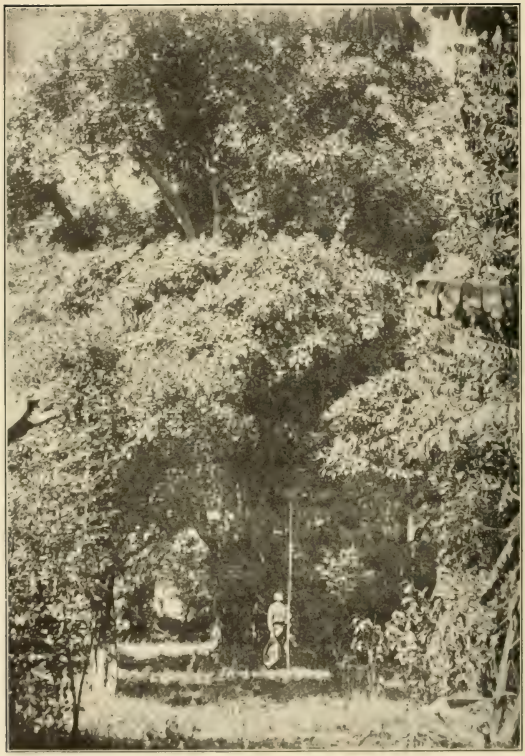


Plate 182. Montezuma Tree No. 33.

MONTEZUMA (NUMBER THIRTY-THREE)

Description: Form, broad pyriform, almost egg-shaped; size, medium large; dimensions, length, four and one-half, diameter, three and one-half inches; weight, fourteen ounces to one pound; base, tapering slightly to stem; apex, very slightly depressed; surface, slightly undulating; color, deep green with few, round, raised, irregular, russet dots, sometimes in the form of patches; skin, thick, granular and hard, separating readily from the flesh; flesh, deep cream; texture, smooth; fiber, none; flavor, mild and pleasant; quality, good; seed, medium, oblate-conical, tight in cavity; season, December to February at Atlixco, Puebla.

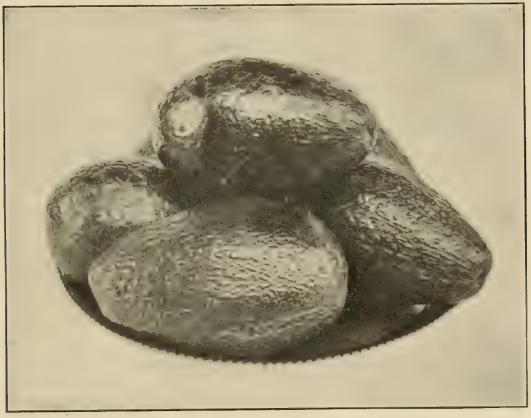


Plate 183. Montezuma Fruit No. 33.

SINALOA (NUMBER THIRTY-SEVEN)

This variety is not to be confused with the one described under the same name in this publication, Vol. 1, No. 1, February 1911, page 16, by F. W. Popenoe. This latter variety is no longer existing and the name has been transferred to the variety described below. This variety is one of the very desirable commercial introductions, being a large fruit of excellent flavor and smooth texture, and coming into maturity at the most favorable season of the year.

Description: Form, oval to pyriform; size, medium large; dimensions, length, seven, diameter, five inches; weight, one and one-half to two pounds;

base, slightly tapering; apex, rounded; stem, stout; surface, rough; color, green with numerous, medium sized, raised, irregular, yellowish dots; skin, thick and tough, separating readily from the flesh; flesh, deep cream, tinged green near skin; texture, smooth and buttery; fiber, none; flavor, rich and pleasing; quality, excellent; seed, medium, round-conical, tight in cavity; season, December to March at Atlixco, Puebla.

Plate 184. Sinaloa No. 37. A fine, large fruit from Atlixco, Mexico.

NUMBER THIRTY-EIGHT

Description: Form, pyriform; size, medium large; dimensions, length, five and three-quarters, diameter, three and three-quarters inches; weight, one and one-quarter to one and one-half pounds; base, slightly flattened; insertion, slightly one-sided; apex, rounded, slightly depressed; surface, rough; color, dark green with rather numerous, irregular, medium sized yellowish dots; skin, thick and tough, separating readily from the flesh; flesh, deep cream, turning to greenish near the skin; texture, smooth; fiber, none; flavor, mild and rich; quality, very good; seed, medium, round-conical, tight in cavity; season, December at Atlixco, Puebla.

NUMBER THIRTY-NINE

This is one of the large types of the finest quality, a royal fruit where this type is desired, especially suited for hotel and similar trade.

Description: Form, pyriform; size, large; dimensions, length, six, diameter, four inches; weight, two pounds; base, slightly flattened; insertion, usually somewhat one-sided; apex, rounded; stem, stout; surface, rough; color, dark green with fairly numerous, small to medium, irregular yellow

dots; skin, thick and tough, separating readily from the flesh; flesh, cream to deep cream, turning to green close to the skin; texture, very smooth; fiber, none; flavor, rich, nutty and delicious; quality, excellent, of the best; seed, medium, round-conic, tight in cavity; season, December at Atlixco, Puebla.

Plate 185. No. 38. A fine fruit of medium size.

NUMBER FORTY

Description: Form, pyriform; size, large; dimensions, length, five and one-half, diameter, three and three-quarters inches; weight, one to one and one-half pounds; base, slightly flattened; apex, rounded, frequently slightly depressed; surface, rough; color, deep green with rather numerous, small to medium sized, irregular yellowish dots; skin, thick, separating readily from the flesh; flesh, cream, turning to green near the skin; texture, smooth and buttery; fiber, none; flavor, rich and pleasant; quality, very good; seed, medium, round-conic, tight in cavity; season, December at Atlixco, Puebla.

NUMBER FORTY-ONE

Description: Form, round-oval to broad pyriform; size, medium large; dimensions, length, four and one-half, diameter, three and three-quarters inches; weight, fourteen ounces to one pound; base, tapering very slightly to stem; apex, rounded, sometimes flattened; surface, slightly undulating; color, deep green with rather few irregular, round, raised russet dots, frequently in patches; skin, thick, hard and granular, separating readily from

the flesh: flesh, deep cream to yellow: texture, smooth: fiber, none: flavor, mild and pleasant: quality, good: seed, medium, oblate-conical, tight in cavity, season, December at Atlixco, Puebla.

Plate 186. No. 39.

MODESTO

A large fruited black variety with a small seed, from Atlixco. It ripens in December and bears an enormous crop. Complete description not available at the present time.

Of all the many different varieties of the avocado sent out to California for trial by the Bureau of Plant Industry, only a few survived the winter of 1912-13. Two of these were from Mexico, and withstood the low temperature without injury. They deserve mention. No. 19206, a green-fruited variety from Coahuila, and No. 19167, a variety from Queretaro. No other descriptions were given.

VARIETIES UNDER TRIAL BY THE WEST INDIA GARDENS

FERNIVAL No. 1

This fruit comes from the Ameca Valley, not far from the town of Jalisco, at an altitude of 4350 feet. The fruit is said to be the finest in the Ameca Valley and is described as being as large as a cocoanut, weighing about two pounds, black in color. The flesh is abundant and of the finest flavor and quality. The seed is medium large and tight in the cavity.

POPOCATEPETL

A large black fruit, slender oval to pyriform, of the thick-skinned type. The quality and flavor are very good. The tree is abundantly productive with off years. From Atlixco, Mexico.

ITZIA

A large oval to pyriform fruit, black in color, with a thick, hard shell. The flavor and quality are of the very best, the seed small and tight in the cavity. Season, December and January.

JOHNSON NO. 5 AND NO. 6

Large hard-shelled fruits of the first quality, from near Colima, Mexico. The young trees growing at the present time in Altadena, show a remarkably vigorous habit. Their leaves are longer than any other variety now growing in Southern California, frequently reaching a length of a foot and a half.

This list brings the imported varieties up to date with the exception of those introduced by Mr. Rideout of Whittier. The descriptions of his fruits are unavailable at the time of writing.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume III MAY 1913 Number 2

Tea Growing in Transcaucasia

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

It is not generally known that tea is successfully grown in the country lying at the east end of the Black Sea, and south of the Caucasus Mountains. Such however, is the case, and it was once my good fortune to inspect the plantation under most favorable auspices, and it has occurred to me that it might be of interest to readers of the Pomona College Journal of Economic Botany, if I should write an account of what I observed.

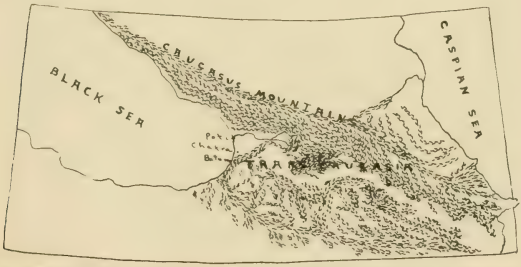


Figure 187. Sketch map of a part of Transcaucasia, showing the location of Chakva and the Emperor's tea plantation.

Just ten years ago (in 1903) I travelled through Russia from Moscow southward across the steppes, to, and finally across the great mountain chain —the Caucasus—which stretches like a wall from the north shore of the Black Sea eastward to the Caspian. North of this barrier is a dry open country where the rich soil when irrigated by the waters of the mountain rivers yields immense crops of wheat and maize, and still further north are the grass covered steppes, wholly treeless except along the meandering streams, quite as on our own Great Plains from Texas to Saskatchewan. South of the

Caucasus range and not more than one hundred miles away the change in climate and vegetation is greater than that usually seen in a distance of half a thousand miles or more. The central and easterly parts of this Transcaucasian region are relatively dry, and here irrigation has long been practiced, but westward towards the Black Sea the annual rainfall increases rapidly until it reaches sixty or more inches near Poti. In this more humid part of the country vegetation is very profuse, the forests being among the densest and richest in the world. In passing it may be mentioned that although this is one of the oldest portions of the civilized world somewhat more than 50 per cent. of the surface is still covered with forests. It would seem that the civilization developed by these people has not required the

Figure 188. Fields of tea plants on the Emperor's plantation.

destruction of the forests, in spite of the fact that the Black Sea ships afforded every opportunity for an extensive lumber trade. And lest some reader might think that perhaps these forests escaped because they were unknown to the outside nations, I will remind him that here was Colchis, the land of the Golden Fleece, that the ancient Greeks knew more than thirty centuries ago. Here on the river Pharis men lived and toiled and built cities, and from these far-away centuries to the present man has lived here. Yet in spite of this long occupancy of the land there are still great forests standing as they stood three thousand years ago.

In this interesting region tea has been grown for many years, and ten years ago I was fortunate in being able to visit one of the plantations under the most favorable circumstances. It is situated near the village of Chakva, between the cities of Batum and Poti, on one of the estates of the Russian Emperor. The estate covers several thousand acres, having a narrow frontage upon the Black Sea, and extending far back eastward into the hills and valleys that lie in front of the low mountains. Near the sea is the Emperor's palace,

Figure 189. Nearer view of tea plants six years old.

and several other buildings, all surrounded by elegant gardens of shrubs, palms, and greensward with an abundance of flowers everywhere. Here Mr. Simonson, the superintendent of the estate, met us, and immediately conducted us to all parts of the tea plantations, passing through thriving plantations of *Eucalyptus globulus*, and tree bamboos (*Phyllostachys*). The tea plantations were back from the sea shore a mile or so, upon the gently rolling hills, and covered large areas of successive plantings. The tea plants were from two to three feet in height, and seen from a distance the fields looked

like extensive plantations of currant bushes with the bushes about five feet apart in regular rows. Nearer by, of course, the shrubs more nearly resembled some of the glossy leaved dwarf almonds. When we visited the plantation the field hands were hoeing out the small weeds between the rows of tea plants, and while the labor was cheap we found that the results were poor. Superintendent Simonson would gladly have employed higher-priced European laborers, feeling sure that in the end he would have had a better return for the outlay. Far better results could have been obtained by the use of horse-cultivators driven by intelligent European, or better still, American farm laborers.

Figure 190. The great tea house or factory on the Emperor's estate.

At the time of our visit,—the latter part of August,—leaf-picking was not going on, so that we did not see this part of the work of tea-making. We were shown, however, how the picking is done, and this appears to be the one difficult and expensive operation in the whole process. Attempts have been made to do this by machines, but with little success. The great tea-house on this estate is a large, plain structure, looking like a very clean and well kept barn, with an unusually large number of windows. It has two stories; in the lower the heavy machinery and the furnaces are placed, while in the upper are the lighter machinery and the tables for the hand-pickers. In this

building we found tea-leaves in every stage from those in the wilting piles to the assorted kinds of tea ready for the market.

We were interested in the heavy machines for rolling the leaves into the characteristic form with which we are so familiar. Each rolling machine consists of a large heavy flat plate about four feet in diameter, on which swings with a rotary motion another heavy, flat plate perforated in its center, somewhat like an old fashioned mill-stone. Above the central hole is a hopper through which are fed the wilted leaves, which later drop from the machine neatly rolled into the desired shape. These rolled leaves are then placed loosely upon flat trays and subjected to the gentle heat of the drying oven.

When dry enough the leaves are dropped upon tables where skilful pickers run over them rapidly and pick out the little sticks and twigs, with other foreign matter that may have become mixed with the tea. It is then passed through cylindrical screens of different fineness of mesh, the different grades of tea depending upon the mesh of these screens. In a row of compartments under these long cylinders one can find every grade of tea down to the coarse "screenings" consisting of little more than twigs and other foreign matter that the pickers failed to remove.

Last comes the packing into cans or paper packages, and the pasting of the appropriate labels. This is done quite as for any other similar commodity. In this particular case, the labels were, of course, in the Russian language, and since the tea was grown and manufactured upon the Emperor's estate this fact was duly set forth, in Russian, also. That this tea is of fine quality we can fully vouch, after testing it many times, and that it is of sufficient importance to find a place in the markets of southern Russia is shown by the fact that we found it in the tea-stores of Jalta, five hundred miles to the westward.

While visiting this tea plantation, and afterward, the question has been, whether there are not places in California where tea might be grown. I have not taken up the questions as to the particular soil and climate necessary for tea growing, preferring to leave that to others, but I venture the suggestion that in the southern half of California there will be found many places between the western sea and the eastern mountain chain where tea can be well grown, and I am sanguine that when once the successful growing of the plants is assured, our ingenious American workmen will be able to surmount the mechanical difficulties connected with the manufacture of California grown tea.

California Street Trees

RALPH D. CORNELL
POMONA COLLEGE

Street trees have furnished the topic of much discussion in California where we never lose an opportunity to expound the subject. They form, as it were, a bone of contention which we can ever gnaw and pick and which seems never to lose the savor that bones of contention are wont to hold. The daily papers continually confront us with appeals for more street trees; we read about their charm and beauty in the Sunday magazine sections; we are enlightened as to their desirability and aid in the healthfulness of a community, in all the farm and horticultural periodicals of the state; and then we go to the meetings of the various horticultural societies and civic leagues to learn why we should plant more street trees. We revel in the lore and fondly picture our home city as it will be a generation, or even fewer years hence, when it shall have become a veritable bower of verdure thru our far sighted planting and tender care of its street trees. It has ever been so.

Every home plants trees in front of its sidewalk. Every small town fills its street parkways with trees concerning which it passes many laws and goes to much expense. They are rather costly to buy; require considerable labor for proper planting; must be nurtured during their youth, lest they die of thirst and neglect; must be pruned, as all young things, to influence their direction of growth and curb their natural desires that seem misdirected. But when we have once established them, they afford such delightful places for the small boy to carve his initials while trying out his new knife, and make such lovely fodder for the old family horse that chews them between naps that he takes while waiting at the curb, that we immediately consider their removal thinking they serve the community too practicably. But why should it be that no sooner do such civic improvements become established than we decide that they are in the way of future development of our little metropolis and so must give way to sidewalks and stone gutters. Why do we plant such things and cut them down, and still continue to gnaw the bone of contention?

Now we all appreciate the beauty of street trees, both in the city and the country, enjoying all the while the cool shade that they furnish from the burning rays of our subtropical sun. If we stop to consider, we cannot but remember that they tend to temper the dry heat of our summers by the vast amount of evaporated moisture that they daily transpire from their leaves; that they break the sweep of our trade and storm winds, stopping and holding the while much of the atmospheric dust; and that they consume the poisonous carbon dioxide gas, exhaling in its stead pure oxygen. We love their grace and charm as we fondly recall some well planted avenue that remains ever fresh in our memories. But we forget all of this as soon as we

see a tree standing where we might put in a concrete sidewalk, were the money available. It never occurs to us to save the trees as other countries have been doing for generations, by leaving sufficient space around them for watering and cultivating the soil about their roots which are protected by placing an iron grating over the opening in the pavement so that the pedestrians may not be hindered although the tree is protected. Paris has thus guarded and reared her city street trees for years, till she has become famed the world over for her beautifully planted avenues. We plant our trees, gorge ourselves with good intentions, rave about the beauty to be and phone

Plate 191. *Eucalyptus viminalis.* Were the palms and smaller trees removed to leave only the stately Eucalypts, the beauty of this street would be increased.

for the gardener with his grubbing mattock, while we prepare a dissertation on "Woodman, Spare That Tree."

However, Californians are not in the habit of satisfying themselves with good intentions but rather pride themselves on their initiative, the fame of which has spread as far as that of the state. Los Angeles has appointed a division of county forestry that has among its duties those of planting out county highways and boulevards with roadside trees. I have no doubt that the members of this commission have worked hard and conscientiously. We know that they have planted miles of our roads to trees that they are caring for carefully—but my! what a choice of varieties to testify to posterity the advanced stage of our development and wisdom in things arboreal. How can

we ever look our progeny in the eye as in the future we drive along a boulevard and say to them that we were responsible for having had it planted as it is? For the combinations are pitiful to see. One eighteen mile stretch of good roads has been planted to Himalayan cedars and California fan palms, alternately set every forty feet—a case of forced association between a graceful, adopted child of the forests with a living feather duster torn from the sun-baked sands of our own deserts; another longer stretch of pavement is lined by native red woods and southern magnolias also planted alternately —the one being a giant timber tree, loving the cool mountain slopes, the other a native of the humid tropical swamps of our southern states; a third road is

Plate 192. Pepper tree (*Schinus molle*) is a graceful tree for street planting.

planted to pines and live oaks. In the first place the trees thus planted together are not adapted to the same climatic and soil conditions, some of them being entirely unfit for satisfactory growth in the localities where set; in the second place, four, with a possible five, of these trees are undesirable for roadway planting because of their characteristic growth; in the third place, two kinds of trees should not be used on the same avenue even though our aesthetic sense demands such a variety. But let this much suffice, for we have shown the proper spirit in starting things, and though good intentions will not buy us much, they are very essential to the accomplishment of good things. And we have once more shown that we, as Californians, have initiative.

Now, this matter of selection of proper trees for such planting is a most difficult one, even for those of us who never make mistakes, since there are a multitude of things to be considered in our choice of varieties. Nowhere else is a tree put to so many tests of efficiency as when it is to be used for street planting. First of all, such a tree should be tolerably drought resistant because the copious amount of pavement surrounding it is sure to interfere with its water supply. It should be of a natural healthy and sturdy growth,

Plate 193. Such a planting of mixed Eucalypts in irregular arrangement is very naturalistic and effective for the country road.

unaffected by ordinary insect pests and fungi that attack many of our trees. And it should not be of a rank growing kind that will produce an excess of brittle wood to be torn and broken by the first severe wind to visit the locality. Ideal trees, answering these requirements, are hard to select, but must be found if the question is to be answered satisfactorily.

But a tree that is perfectly hardy and fitted to survive under such stress of circumstances may not be at all desirable for street planting because of

its habits of growth, shape of head or production of troublesome litter. I feel that one of the prime requisites of an ornamental and satisfactory street tree be that it produce shade, for I can see no advantage in trees that do not. If shade is not desired, a row of telephone poles or even lamp posts would be much less expensive to maintain and equally as effective as some of the formal effects that are made by planting palms that soon come to resemble a row of sticks crowned with bristles. Our most beautiful drives are those that, having become shaded by old trees, soften the glare of our summer sun and offer a restful retreat from its heat, being so far more attractive than our canyon-streets, walled with trees of perpendicular or pyramidal growth, as to be obviously preferable. Then in order that it may afford shade for a street, the

Plate 194. California Fan Palm (*Washingtonia sonorae*). This photograph well shows how the palm will convert a street into a canyon. If of much extent, such an avenue would become tiresome.

tree should be of an upright habit so that it will grow away from the sidewalk and yet shade it. I am sure that pedestrians and autoists alike find nothing more annoying than constant brushing and scratching of trees that have been insufficiently pruned. Similarly, trees producing litter are to be avoided, as a littered pavement is always unsightly, sometimes dangerous to the pedestrian and above all a nuisance. It thus seems wise to choose not only a tree that exists under such unnatural conditions, but also to select one that will fulfill the requirements of an efficient and desirable tree.

After deciding on the variety to plant, we quite commonly dig a post hole in the hard ground into which we insert a small plant, expecting it to grow. This is the cheapest way to plant but the most expensive way to rear trees,

thus enabling us to live up to our reputation of sparing no expense in the beautification of our city. The care that many of our trees receive after this manner of planting comes as a luxury to be enjoyed only on rare and memorable occasions. However, there are so many opposing forces that combine in their efforts to undermine the health of the street tree that it seems only fair for us to apply our wisdom and knowledge to the best advantage of our foliaged friends. For instance, most streets, especially where they have been either excavated or filled, contain very poor soil, often clay or adobe, that contains little plant food, besides being hard for the roots to penetrate; the roots are generally deprived of sufficient moisture because of this hard soil

Plate 195. Cocos palms. This palm makes a graceful and attractive plant for the short or curving drive, but would seem monotonous if planted continuously on a long avenue.

and because the pavement keeps away much of the natural rainfall; the soil around the roots becoming packed, does not permit their proper aeration; salt water is often carelessly poured near the roots of trees in our city streets; illuminating gas may seep through the soil, injuring the roots if not destroying the life of the plant; injurious gases in the air, damage from overhead wires or the gnawing of horses may all conspire to injure the tree. These things work against the healthy, thrifty existence of these children of the forest transplanted into an unnatural city environment, undermine their health, threaten their very lives, so that we should bend our efforts to prevent and overcome such detrimental influences.

One of our local horticulturists and botanists is fond of saying that a ten cent tree planted in a fifty cent hole will soon outgrow and always surpass in healthful vigor a fifty cent tree planted in a ten cent hole. He is quite right. Too much attention cannot be given to the preparation of the soil bed that acts for the plant as does the foundation for a building; for it lies at the bottom of the tree's health, theoretically and literally. Where the soil is poor, a hole should be dug from three to four feet deep, sometimes as long as twelve or fifteen feet, and filled with light, loose, rich loam obtained especially for the purpose. If a hardpan exists anywhere near the surface of the ground, the bottom of the hole should be shot with dynamite to crack this layer, thus assuring drainage and conservation of the moisture. Now such preparations seem rather extensive and expensive, but nevertheless become capital stock

Plate 196. Blue Fan Palm (*Erythea armata*). This well illustrates how our public service companies are allowed to ornament the streets. They show even less taste than the ordinary tree planters.

for the city that really desires to have avenues of beautiful trees, for they will save much later expense that would otherwise become necessary, aside from greatly increasing the growth and beauty of the trees.

Now that we have set the tree it might be well to see what we have planted, though this does not generally seem to worry the planter very seriously. I, personally, feel that trees of pyramidal or straight, slender habits of growth are not satisfactory as street trees in California, for they not only afford no shade, but they shut out the wind, reflect the heat from the smooth pavement and add a stiffness and formality to the landscape that detracts from its beauty and becomes monotonous. Most of the palms and conifers fall quite naturally under these two heads and are also being quite generally used as roadside trees.

Take the Himalayan cedar (*Cedrus deodara*), which is a handsome and graceful tree in its place, when planted as an avenue tree. In the first place, it must be allowed to retain all of its lower branches if it is to retain its graceful charm, thus necessitating its being planted along country boulevards that do not have sidewalks paralleling them. In the second place, it encloses the street between two shining green walls that furnish no shade the while they reflect and counter-reflect the radiated heat of the sun. It is of an inimitable beauty as a specimen or lawn tree where it can expand as nature intended, but planted along an avenue, it poorly serves a purpose for which it was not intended. This cedar serves as an example of the conifer type

Plate 197. Golden bamboo (*Bambusa aurea*) is very attractive on a short or curving drive, but excludes all circulation of air when planted so closely. Giant bamboo, planted in clumps, would well adorn an occasional avenue.

which is quite commonly, though, I think, unwisely, used in our roadside plantings.

While the palm will grow up and away from the sidewalk and street as the conifer will not, nevertheless it fails in the requirements for a tree suitable to plant along drives of any considerable length. Where formality is desired, or if planted along short or curved stretches of driveway, the palm is very beautiful. But it does not accord with my ideas of an ideal boulevard tree, because it lacks an umbrageous head and possesses an excessive expanse of bare trunk that becomes monotonous to the eye. One of the accompanying

illustrations well shows what a canyon the palm will in time make of a street. Although while young, many of the palms seem very graceful and beautiful, as they age and shed their old leaves leaving nothing but a bare trunk surmounted by a tassel high above the ground, they present an appearance that becomes tiring if viewed continuously for miles along a country road. The same fault is to be found with the Italian cypress (*Cupressus sempervirens*) and the poplar trees that grow perpendicularly into the air with scarcely any lateral branches. So, in a general way, I would discourage the planting of palms and slender types of trees along avenues of any length.

Plate 198. Olive (*Olea europea*). Hardy, enduring, graceful and ever ready to do service as a street tree.

In relation to street and roadside planting in California, much is said in favor of planting evergreens and nothing but evergreens, even though some of our most beautiful shade and avenue trees are deciduous. Especially along the sea coasts, where the winters tend to be damp and foggy, would it seem advisable to plant an occasional street to a deciduous variety that would admit the light and air during the winter months when the roadways and walks are so apt to be damp and disagreeable. At the same time, such a tree would afford shade in the summer when it is most needed. Some of our most beautiful shade trees are deciduous and I do not think that it gives our landscape a bleak or desolate appearance to possess an occasional clump or avenue of trees that are without their leaves for a few short months of the

year. As a matter of fact, it rather tends to afford contrast with our evergreens, making us realize all the more the wealth of possibilities that our state affords for the growth of different types of flora.

In connection with this word on deciduous trees, I should like to mention among others the native sycamore (*Platanus racemosa*), one of the most picturesque features of our landscapes, both in winter and summer. This hardy tree, admirably adapted to stand the rigors of our climate, should make a good street tree, though I do not remember having ever seen it so planted. Another tree which all Southerners love and which Professor Charles F. Baker of the University of the Philippines strongly advocates, is the tulip tree (*Liriodendron tulipifera*), said to be well suited to avenue planting. One of its characteristic features is the abundance of beautiful

Plate 199. Blue gum (*Eucalyptus globulus*). The old stand-by; tall growing, stately, worthy of California.

flowers that it annually produces. Again, the common chestnut (*Castanea*) thrives well in California, where it fruits to perfection. These trees are all beautiful, hardy, popularly liked; why not plant them on some of our avenues?

Among our commonest and, I think, most beautiful street trees is the pepper tree (*Schinus molle*) which receives much censure and fault finding from the multitudes. It is true that it harbors scale in an infected district where it is neglected and starved; but so do our fruit trees. If, however, a pepper is given occasional water and kept in a healthy growing condition it is found to be remarkably free from insect pests, reducing this tendency to the minimum. It is true, also, that the pepper berries produce annoying litter at certain seasons of the year, but their beauty would more than atone for a considerable inconvenience during this short time. Besides, the combination of the rugged, twisted trunk and feathery, drooping foliage is hard

to excel. This tree will turn a barren, sun-beaten street into an inviting, shady lane so effectively and in so short a time that we should not bar it from our midst for a few minor faults.

In close competition with the pepper, probably exceeding it in numbers, is the Eucalypt in a number of species, the most usual of which is the blue gum (*Eucalyptus globulus*). This is a very rapid, tall growing tree that adapts itself well to the atmospheric conditions of the sea coast. At the same time, it makes an attractive avenue tree where ample space permits its development, and when planted on an avenue of sufficient width to bear well its height.

In our hot inland valleys, the blue gum is supplanted by the manna gum (*E. viminalis*) which grows almost as fast as the former, standing at the same time a much wider range of temperature and thriving where the blue gum will not exist. After a few years, its branches assume a pendulous position that gives to the tree a very pleasing grace and ease of carriage. It is seldom seen as a street tree, but is well suited for planting along our country roads where it has space for its rugged development.

Another tree that should prove desirable for country road planting, in districts that are not visited by heavy frosts, is the Moreton Bay fig (*Ficus macrophylla*), a tree that attains an ultimate height of 100 feet with a spread even wider. Due to the buttressing habit of the roots and to its immense size, it is not suitable for general city planting but would make a most majestic avenue tree, where room permitted. The native live oak (*Quercus agrifolia*) and the cork oak (*Q. suber*) are quite similar in general appearance, although the cork oak grows more erectly and more rapidly than the common live oak. Both of them make admirable avenue trees when matured, but because of their slow growth are often rejected by planters. It would seem, however, that we are planting trees for the coming generations as well as for the present, so that a mere matter of slow growth should not bar a tree that is so beautiful and serviceable as the oak.

A tree that I have never seen on a street, but which would look well on a country road of average width, is the native Island iron-wood, (*Lyonothamnus floribundus*, var. *asplenifolius*). This tree is wonderfully tolerant of drought and the steady cold trade winds of our coast. It has a fernlike foliage and white flower clusters, both drooping gracefully. It produces a hard durable wood that is not easily broken by winds; so that all in all it seems to fulfill remarkably well the tests of endurance that are levied upon a street tree.

Although one might need to protect such fruiting trees with the national guards or at least a burglar proof fence, the avocado (*Persea gratissima*) would make a beautiful, shade-producing street tree. Its foliage is of a bright lustrous green. Its habit of growth is large and spreading. It is a rare fruit tree. But as Germany has made a successful practice of planting fruit trees along her highways, which were thus made to pay for their own upkeep through the harvest and sale of their fruit, why could not Californians show

their progressive spirit by trying such a scheme in this state? The avocado is the solution of the question.

In considering trees that would be fitted to live in our city streets we are confronted with a somewhat more serious problem, because of the necessarily cramped space that does not allow either proper root or proper head development of large trees. One of the saddest mistakes that can be made is to plant a large growing tree in a narrow, cramped street that eventually becomes filled and clogged with its branches. Therefore, we should constantly bear in mind the sense of proportion so that the trees which we plant might appear to the best advantage. Tables have been worked out by municipal specialists who give the proper sizes of trees to balance and harmonize with streets of certain widths and lined by buildings of certain heights. These are obtainable by the person who cares, so that excessively bad mistakes need not be made.

For city planting, the Acacia has been used very much throughout the state, many times in much inferior varieties. As a general thing it has so brittle a wood that it is easily broken by the wind or the weight of its own flowers. Some varieties, especially *A. melanoxylon*, the black wood Acacia, sucker from the roots, thus becoming very troublesome in the parkways. There are kinds, however, that if given proper and intelligent care make a very attractive tree that is well worth one's bother. The vast number of varieties of this genus permits much leeway of choice.

The common camphor (*Cinnamomum camphora*) is frequently seen, though often accused of growing ununiformly in height, when planted along a street. I think that were this tree properly planted and cared for, it would make a most satisfactory tree for this purpose, as it is of an upright habit of growth, with a compact head and beautiful glossy foliage. In time, too, it will grow to a considerable height.

The carob tree or St. John's bread (*Ceratonia siliqua*) has recently become something of a favorite for this line of planting. It is comparatively slow of growth and spreading in habit, but if properly trained and encouraged will grow into as fine a tree as any of the more promising seedlings. Its dark glossy foliage gives it a richness of color that is hard to equal, while its branching head makes an ideal sun shade. It will stand dry weather, heat and cold in a way that makes it valuable for planting in a varied range of localities.

Although *Pittosporum undulatum* is subject to scale, especially when neglected, it is well adapted to street planting in the residence districts of our cities. It has a profusion of sweet scented bloom in the spring, followed, unfortunately, later in the season by dropping seeds and seed husks that strew the ground beneath. A close relative to this tree is *P. rhombifolium*, quite similar in habit though probably higher growing and a little more desirable than *P. undulatum*.

The Catalina cherry (*Prunus integrifolia*), a native of Catalina Island, makes a beautiful small tree with a spreading head and sufficient size to warrant planting it on a small street. The foliage of this tree is a rich glossy green; the tree blooms profusely and produces a red cherry that is rather attractive in appearance.

The mayten tree (*Maytenus boaria*) grows to a medium height in a quiet, modest way. Its foliage is fine, graceful and drooping, though rather sparse and casting only a moderate shade. Its size would not be sufficient to balance and harmonize with a wide street, but is enough for some of our more narrow city ways.

A tree that is sometimes seen along our roadways, but which in my estimation might well be planted oftener, is the common olive (*Olea europea*). It has a delicateness and softness of outline that seems to blend with and soften the tone of almost any environment in which it is placed. It is very hardy, drought and cold resistant, so that one need not be especially careful of the locality in which it is planted. It makes a comparatively slow growth, but is long lived, attaining an ultimate height sufficient for the ordinary street. However, if the fruit is unpicked, its litter is very troublesome and dangerous.

So much for varieties. There are faults that might be found with all of the plants that have been here mentioned, although, judging from what one commonly sees, many of us cannot be overdiscriminating in our choice of street trees. Time only will tell us of that which, making a splendid growth while young and seeming to be happily chosen at the time, may turn out to be absolutely unworthy after a few years have given it an opportunity to demonstrate its value. So, too, is it that the unpromising seedling may in the end prove to be the best possible tree for the purpose.

The accompanying half tones give some examples of good and bad planting, and good and bad selection of road trees. And although it is largely a matter of personal taste as to what is beautiful and what is not, there seem to be certain requirements that a satisfactory tree must fill. Careful consideration, deliberate judgment and common sense, if judiciously used, will solve many of these hardest problems for us.

Babylonian Dates for California

PAUL B. POPENOE
EDITOR OF THE JOURNAL OF HEREDITY, WASHINGTON, D. C.

The greatest date-growing region in the world is the country between Mesopotamia and the Persian Gulf, which is now properly called 'Iraq and is a part of Turkey in Asia, but which I shall call by its ancient name of Babylonia, as more familiar to Occidentals. Its dates, which we have been accustomed inaccurately to call "Persian Gulf dates," have long held a practical monopoly of the American market; but when the culture of the palm began to be taken up seriously by California ranchers, they drew nearly all their stock from Algeria, because of the greater accessibility of the North African oases.

Most of the varieties thus secured, however, are late in maturing, and when they became well established, it was realized that an extension of the season, by the addition of earlier varieties, would be of great value to the industry here. Late dates like Deglet Núr do not get into market until the fresh importations from Babylonia have arrived, and they must compete with a flood of fruit which can be laid down in the United States for less than five cents a pound. If, however, California growers can market a considerable portion of their crop in August and September, they will have a market empty of dates, when any good fruit will find a ready sale at a remunerative figure.

It was known in a general way that the Babylonian varieties would meet this need. The Bureau of Plant Industry of the United States Department of Agriculture had introduced a number of them on an experimental scale, following a visit of David Fairchild to the region in 1903, and among the varieties thus secured were several that ripened earlier than anything theretofore known in the United States. In fact, Arizona growers did not hesitate to say that the "Persian Gulf" varieties would practically be the making of the industry in their state,* since the best from Algeria matured at a time at which the crop was usually ruined by rain.

Under these circumstances, the West India Gardens, of Altadena, Los Angeles County, California, sent me to the region in question, to spend the winter of 1912-1913, make as full a study of the date varieties as possible, and introduce the best of them to the United States on a large scale. I began with a visit to the home of the Fardh date in Oman,† on the eastern coast of Arabia, and then spent nearly four months in Busreh, near the head of the Persian gulf, and Baghdád, 500 miles farther north. In this region I was able to list 112 varieties of dates, descriptions of most of which, including

* Popenoe, Paul B., in Bul. Calif. Comm. Hort., I, 10, p. 877. The Arizonans have since come to prefer Egyptian dates.

† Popenoe, Paul B., in Bul. Calif. Comm. Hort., Jan., 1914.

even many of the best, have never before been published, and to bring to California 9,000 offshoots, which arrived in remarkably good condition and are now divided between many growers in the Coachella Valley and elsewhere.

It is my purpose in this paper to describe the varieties of dates grown in Babylonia, not only for the importance which such descriptions will necessarily possess for Californians growing the varieties in question, but as a guide for future visitors to that region; for I believe it is the most promising known, from which to draw a large supply of high-grade offshoots for the United States.

Although the dates of Busreh are better known, and more important commercially, and are now and always have been* considered, even by Arabs, as the best, my opinion—as is that of my brother, F. W. Popenoe, who accompanied me, and to whom I am indebted for much assistance in preparing descriptions—is that the Baghdád field is incomparably richer. Commercialism at Busreh has tended to restrict planting to the three great export varieties, Haláwí, Khadhráwí and Sáyir, and none of these can be considered a superfine date, although for a steady diet Khadhráwí is as satisfactory as any grown. Yet Haláwí is more profitable, since its lighter color makes it a favorite in the American market. The price received for this variety by growers in 1912 (when the crop was large) was $2.22 per maund of 153 pounds. The prices of Haláwí, Khadhráwí and Sáyir, respectively, were in that year as 320:260:220. There is, thus, no doubt as to what is the most profitable date at Busreh, the choicest varieties, like 'Awaydí and Barhí, being cultivated to a very limited extent indeed.

In Baghdád the dry date Záhidí is most widely cultivated, and there are no virtues which growers do not ascribe to it. There are many finer ones, but Záhidí has come to be the choice of the nomad tribes who are the chief consumers of Baghdád dates, and as it is early, hardy, vigorous, and unusually prolific, the growers plant it so largely that many groves contain nothing else. It is usually considered the most profitable there, but some growers put Khustáwí ahead of it, because of the higher price it commands, in spite of its lighter yield; Asharasí, Maktúm and Tabirzál probably come next in order, but the last two are hardly cultivated on a commercial scale and, as a matter of fact, one sees Busreh Khadhráwís sold in the Baghdád bazar more frequently than any of the local varieties.

The first ripe dates are eaten by the natives in July, but it must be admitted that an Arab will eat dates when they are still so hard and full of tannin that American hogs would hardly touch them. Perhaps August first might be taken as the commencement of the date season in an average year, while it is not in full swing until a month or six weeks later. Within a month all of the principal varieties have been picked and sold; in forty days the

* Besides mediæval Arab writers, cf. Marco Polo's description in the latter half of the 13th century, "There is also on the river (Tigris) as you go from Baudas (Baghdád) to Kisi (Kish) a great city called Bastra (Busreh; classically Busreh), surrounded by woods, in which grow the best dates in the world."—Yule's Ed., I, 60, London, 1871.

packing season is virtually over. The extremely early dates of Babylonia are Ibráhimí, Halawí Makkáwí, Balabán, Makkáwí Ashqar, Bárbán, Badinjání and Sultání, while Záhidí and the Busreh Halawí will have to be put on the edge of the list.

The later dates, on the other hand, continue to ripen well up to December first. Khasáb, Hilálí, Shatwí, Lúlúí and 'Amámet al Qadhí can be had fresh in any quantity up to the middle of November at least.

The dates of the region average well in size, and the dry varieties, in particular, are conspicuously larger than the similar dates of Algeria; they are also of better quality, on the average, while the best of them reach a perfection that was never dreamed of in the Sahara. Babylonia's largest dates, I should say, are 'Awaydí, Bú Saba'a al Dra'a, Madaní, Sayyid Ibráhím and Ism'aíl Qadrí,—all of them rare.

Arab scientists classify the principal varieties as hot or cold, according as a long-continued and exclusive diet of them "burns" the stomach or not. The distinction is important in a country where people eat little except dates, but it will not be worth considering in the States, where a handful a day is a heavy ration. Khustáwí is universally considered the coldest date known: one can eat five pounds daily for a year and never feel them. Bárbán, at Baghdád, is considered the hottest, but is valued, nevertheless, on account of its earliness. As a matter of fact, not only most of the varieties, but most of the choice varieties, are considered hot. Among the cold ones are Khadhráwí, Sukkarí, Shukkar, Amír Hajj, Sukkar Nabat, while Maktúm and Badráhí are placed in an intermediate class, neither hot nor cold, but satisfactory. Asharasí, Tabirzál, Halawí, Záhidí, and Barhí, most of the other dates of sufficient importance to receive classification, are on the hot side of the ledger.

As to the best date of the region, Arabs agree in awarding the palm to the Khaláseh of Hasa* which, however, is little grown outside its original home. I think this judgment is correct. My own second choice is Maktúm or Tabirzál, but many of the Baghdádís swear by Sukkarí—in fact, that would probably have more votes than any other at the City of the Caliphs. Khustáwí has many admirers. The originator of the variety Khiyára declares that none can equal it. Those partial to dry dates affirm that nothing surpasses Asharasí. At Busreh, 'Awaydí and Barhí are tied for first place. Sultání is the choice of the Hilleh growers. Amír Hajj is esteemed, but the rare Jamál al Dín, Baqlah and Gul Husaíní from the same region are considered quite as good, if not better. Those who have tasted Khasáwí al Baghal call it excellent. Brím is considered one of the finest known dates at Baghdád, while at Busreh it is held to be fit only for boiling. In short, it is all a matter of taste, but if one took Barhí, 'Awaydí, Khustáwí, Maktúm, Tabirzál and Sukkarí as the best of the region, he would not be far wrong; leaving the

* Cf. Palgrave, W. G. Narrative of a Year's Journey through Central and Eastern Arabia, vol. II, p. 172, London, 1865.

others I have mentioned as second choice, with the incomparable Khalásch always in a special place of honor.

As for the worst ones, the two Sáadas, Sharisí, Ja'afarí, Hamráwí, Haláwí and Asshag will have to fight for the leather medal among themselves. One sometimes finds in the bazars worse dates than any of those, but they are merely seedling fruit. The varieties named are as bad as any one would care to perpetuate.

Methods of culture differ little in Babylonia from those in other Arab countries, and I therefore omit any description of it, particularly since it has been treated by Fairchild* fully and satisfactorily.

In transliterating the Arabic names of date varieties, I have followed the system now universally adopted by scientific men—namely, that consonants should be pronounced as in English and vowels as in the continental languages —e. g., Spanish. This system, which was elaborated by the International Congress of Orientalists at Geneva in 1894, has the merit of being both uniform and simple.

The following list, arranged in alphabetical order, contains the varieties which I was able to list in Babylonia, either from my own observations, or from the descriptions of native acquaintances; but as I have recently published† descriptions of most of the varieties now in California, at some length, I omit these in order to save duplication. For the following Babylonian varieties the student should, therefore, consult my book on Date Growing:

Anjasí, "The Pyriform."
Asibi' al 'Arús, "The Bride's Fingers."
Asharasí, "The Tall Growing."
'Awaydí, "The Little Big One."
Bajlání, named after a tribe of noted date-growers.
Badinjání, "The Egg-Plant Date."
Bárbán, "The Fair Persian."
Barhí, named after a hot wind supposed to ripen it.
Brím, (origin of name disputed).
Dubaíni, named after the oasis of Dubai, near Baghdád.
Fursí, "The Persian."
Guntár, properly *Qintár*, "The Hundredweight."
Haláwí, "The Sweet."
Haláwí Makkáwí, "The Sweet Date of Mecca."
Hasan (or *Husaín*) *Effendi*, (a man's name).
Hasáwi, from Hasa.
Ibráhimí, "Abraham's Date."
Khadhráwí, "The Verdant."
Khustáwí, "The Date of the Grandees."

*Fairchild, David. Persian Gulf Dates and their Introduction to America. Bul. No. 54, Bureau of Plant Industry, Washington, D. C., 1903.

†Date Growing in the Old and New Worlds, by Paul B. Popenoe. West India Gardens, Altadena, Cal., 1913.

Maktúm, originally *Makdúm,* "The Bitten."
Maktúm Ahmar, "Red", a variety of the preceding.
Shukkar, "Sugar."
Sukkarí, "Sugary."
Sukkar Nabat, "Refined Sugar."
Sultání, "The Sultan's Date."
Tabirzál, originally *Tabirzád,* "Sugar Candy."
Záhidí, "Nobility."

The varieties in the foregoing list are all to be found now in the United States. The following list comprises all the other varieties of which I could learn in Babylonia; they are not growing in the United States, unless so described, but many of them should be given a thorough trial as soon as possible.

OTHER BABYLONIAN VARIETIES

'Abadlí, "The Date of Abdullah" (a man's name), a large, soft date, light reddish-brown in color, grown principally in the oasis of Baqúbah, near Baghdád. Usually eaten fresh, but keeps well if packed tightly. Ripens about the middle of September. Quality good. Yield fairly heavy.

'Amámet al Qadhi, "The Kadi's Turban," a large, yellow, dry date, very thick in proportion to its length; ripens late in season and is of mediocre quality. Mostly eaten fresh, but not a common date. Seed large. It is occasionally picked when still soft and packed in skins.

Amír Hajj, "Leader of the Pilgrimage," a date practically confined to the oasis of Mandalí on the Persian frontier. It is ranked among the best dates of Babylonia, partly because of its quality and partly because of its attractive appearance and its scarcity. Nowadays it seems to be exported only in the form of presents. The few trees are in the gardens of wealthy men who refuse to sell offshoots from them, consequently the variety is not disseminated.

The palm is tall and graceful, but very delicate, requiring a great deal of cultivation and water; a shy bearer. It matures its fruit in midseason.

Many seeds of this variety have been planted in California, all efforts to secure offshoots having failed.

In form, the date is broadly oblong-oval to oblong-ovate, flattened at base, widest at or near center; apex rounded to broadly pointed, base flattened. Size medium large, one and one-quarter to one and three-eighths inches long, seven-eighths to one inch wide. Surface dry or nearly so, roughly undulating, slightly glossy where the thick bluish-gray bloom has been rubbed off; deep, rich orange brown in color, unusually translucent. Skin firm but rather thin, not easily broken, though tender; loosely folded, the folds rather prominent but only occasionally separating from the flesh; no blisters. Flesh three-eighths inch thick, of caramel consistency, translucent, light golden brown in color; fibrous lining of seed cavity yellowish cream colored, fibre tender

and unnoticeable in the mouth. Seed rather small, three-quarters inch long by one-fourth to three-eighths inch wide, oblong to oblong-obovate, blunt at base, slightly tapering at apex; smooth; deep, dull brown in color; ventral channel almost or entirely closed; germ pore at or near center. Flavor very rich and pleasant, not so sweet as to be cloying nor so strong as to be objectionable. Although the date somewhat resembles Maktúm in appearance, the flavor is entirely different.

'Arab Síkí, (Turkish), "The Arab's Phallus," a variety mentioned by G. Ghanímeh in an article on the Palms of 'Iraq in Al Machríq. No. 11, p. 480, Bayrút, June 1, 1907. I could not find this variety.

Asharasí Aswád, ("black"), a rare sub-variety of Asharasí at Baghdád. Form broadly obovate, sometimes almost spherical; base broad and flattened, apex rounded to very broadly pointed. Of very solid consistency, but not hard. Size medium large, length one and one-fourth to one and one-half inches, breadth one to one and one-eighth inches. Surface dry, rough, slightly glossy, deep purplish maroon in color, bloom unnoticeable. Skin rather dry, moderately thick but not tough, coarsely wrinkled indiscriminately, and toward apex separating from flesh in numerous folds and blisters. Flesh solid, gummy, one-fourth inch thick, translucent light brown under skin one-third of distance to seed, the rest light straw color. Slightly fibrous around seed cavity. Seed broadly oblong, blunt at base, rounded at apex, plump, eleven-sixteenths inch long, five-sixteenths broad, smooth, cinnamon brown in color, ventral channel open, rather shallow, germ pore slightly nearer apex. Flavor rich and nutty, quite similar to that of Asharasí.

Ashqar, "Sorrel," referring to its color. This is the Busreh name; at Baghdád the word is made feminine instead of masculine: Shaqra. A long slender date of rather above average size, sorrel colored, ripening in September. Considered good when fresh, but does not keep well. Bears heavily. Not common in either district.

'Ashárí, a name which indicates that the date ripens in the first ten days of the month,—but I do not know which month. It is a very rare Baghdád soft date, resembling Khustáwi but a little larger. Ripens in midseason; yield good; the date is noticeable for its tender skin.

'Ashshaiq, "The Preferable," I take to be the true form of the date vulgarly called "Asshag" at Busreh. It is a mediocre variety ripening in October. Long and slender, almost black; keeps well but is not good as rutab (fresh dates). Bears heavily. Not common.

Awashah, (a woman's name), originated in a garden owned by a woman of that name at Mu'adhdham, near Baghdád, and is confined to that neighborhood. Yellowish brown in color, long and of medium thickness; midseason. Opinions differ as to its value, some declaring it worthless while others represent it as a delicious fruit with notably tender skin.

Aweriba (??), variety reported from Hilleh, of which I could get no description.

Azraq, "Brilliant," a good soft date principally grown at Mandalí and Badra. Form oblong-ovate, rounded at base, broadly pointed at apex. Size medium, length one and one-fourth to one and one-half inches, breadth at widest point, at or near center of fruit, five-eighths to three-fourths inch. Surface rather rough, light brown in color, glossy, bloom unnoticeable. Skin firm but thin, rather tough, loosely wrinkled indiscriminately, occasionally blistered, but otherwise adheres closely. Flesh very firm and of caramel consistency, good texture, three-sixteenths inch thick, translucent, light reddish brown in color, slightly fibrous near seed. Seed oblong, slightly pointed at both ends, three-fourths to seven-eighths inch long, five-sixteenths inch broad, smooth, grayish brown in color, ventral channel open but narrow. Flavor sweet but the taste of syrup rather more prominent than that of dates.

Banafshah,* "Violet Blossoms," a dry date of attractive appearance but ordinary quality, grown around Baghdád but more at Mandalí. Form oblong, slightly swollen toward the apical end, the base bluntly flattened, the apex rounded or very broadly pointed. Size medium large, one and one-fourth to one and one-half inches long, five-eighths to three-fourths inch wide. Surface smooth or coarsely wrinkled longitudinally, dry, hard, dull purplish maroon in color with slight bluish bloom. Skin thin, dry, moderately tough, adhering closely except for an occasional fold, usually somewhat wrinkled toward apex and smooth near base. Flesh dry, solid, mealy, one-eighth inch thick, dull white in color, sometimes slightly soft near apex. No fibre. Seed very large, oblong, blunt at base and rounded at apex, one inch long, five-sixteenths inch broad, smooth, fawn colored, ventral channel open, deep, germ pore slightly nearer apex. Flavor sweet but lacking in character.

Baglah, "The Pot Herb Date" (?), a large, yellowish brown date with small seed, which ripens about the middle of September and is known as a heavy bearer. Considered best when fresh, but, also, packs well. It is rare, if known at all, in Baghdád, and seems to have originated somewhere on the Persian frontier. Those who have eaten it call it delicious. I ordered some offshoots of this variety from Badra and received four specimens labeled "Daklieh," so I do not know whether I introduced it to California or not. Sayyid Salman Abatshí who is considered an authority on dates at Baghdád, declares it is the best variety in Babylonia.

Badami, "Almond-like" (Persian), a rare Baghdád soft date which is highly esteemed. Medium large, light brown in color; ripens early in September. Eaten as rutab (fresh dates) or packed in skins or boxes.

Badráhí, from the oasis of Badra, although those of Mandalí are considered better. The palm flourishes in a sandy soil and is rarely found at Baghdád, in fact, I was unable to secure any offshoots of it. The date is much liked by the Baghdádís, but the whole supply is shipped in. The palm

* This is the Persian word, but is usually heard at Baghdád, as are many other Persian words, because of the large Persian population there. The classical Arab form *Banafsaj* is, also, heard; it is merely a corruption of the Persian; by the time the word reaches Algeria it has degenerated to *Balasfanj*.

is easy to cultivate, but bears moderately; it has been a decided success in California. Season, late September.

Form broadly oblong, tending to oblong-oval and oblong-obovate, broadest between center and apex. Base slightly flattened, apex broadly pointed. Size medium to medium large, one and one-fourth to one and three-fourths inches long, seven-eighths to one and one-eighth inches wide. Surface hard and dry, smooth to roughly undulating, rarely wrinkled; brownish straw colored, sometimes darker toward apex and lighter toward base. Skin hard, dry and brittle, adhering closely to flesh and rarely wrinkled or folded. Flesh three-eighths inch thick, light straw colored, very hard and solid, not mealy, free from fibre. Seed oblong-elliptical, slightly tapering at base and pointed at apex, three-fourths inch long, five-sixteenths inch wide, fairly smooth, deep brown in color, ventral channel open, narrow; germ pore slightly nearer apex. Flavor remarkably sweet and delicate, almost honey-like, with very little of the nutty flavor that characterizes *Asharasí*.

Bayt al Sabáh, "Breakfast Food," a scarce Busreh variety of slight value. The fruit is large, short and thick, light brown in color, and ripens about October first. Principally eaten as rutab; the dried date keeps fairly well but is inferior. Heavy bearer.

Balabán, perhaps "The Date of Bán," a region in Arabia always famed for its dates. A small, short, brown, soft date which seems to be confined to one garden at Baghdád and is said by its possessor to ripen almost a month before any other. The palm is of rank growth, resembling a male in appearance, and bears well. The dates are eaten fresh, packed in skins, or cured to a caramel consistency.

Burní, "The Sweetmeat Jar"* (Persian). An Oman variety, very rare at Baghdád. I met men who had heard of it there but never one who had actually seen it.

Bú Saba'a al Dra'a,† "Father of Seven to the Cubit," describing its length. This is the name at Busreh and Abu'l Khasíb; at Baghdád it is called merely Saba'a al Dra'a. A long and slender variety of mediocre quality, very rare and grown more as a curiosity than anything else. Dark brown in color. The fresh fruit is not good, nor is it much better when fully mature.

Busráwi, "From Busreh," a variety grown at Baghdád, but not common, although esteemed because it bears early (August). A large, soft date, of which two sub-varieties are distinguished, "Asfar" or yellow and "Ahmar," red.

Chayán, "Tea-flavored" (Persian), a variety of which I heard the name only.

* This derivation was given me in Masqat, and is quite legitimate. Birní is one of the most famous classical varieties, and all ancient authorities mention it in Babylonia; I can not prove, however, that the present Burní is identical with it. There seem to be two or more varieties confused under the latter name at present. The etymology of Birní is certainly not that given above.

† Properly the word should be transliterated *Dhira'a*. There are three cubits in use at Busreh, of 18, 25 and 27 in., respectively.

Chibchab, see Kibkab.

Dafr al Ghazál, "Gazelle's Dung", a Busreh variety, very scarce, eaten only as rutab. Of medium size and slender, yellowish brown in color, ripening about September fifteenth. Quality good.

Degal 'Abbás, "The Date of Abbas" (a man's name). A rare but esteemed Busreh variety whose fruits ripen about October first. The date is small, long and slender, light brown in color. Bears at an early age and heavily; the fruit keeps well.

Degal 'Amad, "The Columnar", a Mandalí variety, of which a few palms exist at Baghdád. Very small, no larger than the end of one's finger, but of good quality. Light brown in color and of moderately soft consistency when cured, but usually eaten fresh.

Degal Khatún, "The Lady's Date," a scarce and inferior Baghdád dry date, also eaten rutab. Yellowish-brown; midseason.

Degal Múza, "The Banana Date," a Busreh variety probably identical with Qush Múza of Oman. Fruit small, short and of medium thickness; same color as Khadhráwí. Ripens September fifteenth to twentieth. Eaten fresh; keeps well but is not so good when cured. Yield good. Most gardens of any size have a few trees of this variety to provide early rutabs (fresh dates) for family use.

Dairí, said to mean "Of the world," i. e., "grown everywhere," but it is possible that it means the Monastery Date, referring to the famous Daír al Balah (Monastery of Dates) at Gaza (Ghazzeh) in Palestine, where the Egyptian Hayání, called Birket al Hajjí in America, is much grown. If so, the Busreh Dairí would be Hayání (Birket al Hajjí). It is one of the commonest "soft and dry" dates of Busreh, but of inferior quality. It is sometimes packed in skins as a soft date. The offshoots come into bearing at an early age, but the yield is always rather light. Not eaten in the fresh stage. Ripens about October first.

Form oblong to oblong-ovate, widest near center, whence it narrows slightly to the broad and obliquely flattened base, and more pronouncedly to the broadly pointed apex. Size large, one and one-half to one and seven-eighths inches long, three-fourths to one inch broad. Surface almost smooth, translucent brownish red to light maroon in color, overspread with a thin, gray-blue bloom. Skin thick, tough, adhering closely except for occasional longitudinal or transverse folds; wrinkling almost none. Flesh firm, tender, one-quarter inch thick, translucent, deep amber colored. Seed oblong, blunt at base, slightly pointed at apex; one inch long, three eighths wide; smooth, light brown, ventral channel broadly open, germ pore two-thirds of distance from base to apex. Flavor sweet but lacking in character and with unpleasant after-taste.

When allowed to become dry, the date is similar to the above, save that the flesh around the base becomes whitish, opaque, granular and dry, sometimes extending in a layer around the seed cavity, almost to the apex of the fruit.

Findúqíeh, "The Filbert," an alternative name for Jaúzí.

Gul Husaíní (Persian). The Rose (or Flower) of Husaín (a man's name), an extremely rare variety from Mandalí, on the Persian frontier; it is apparently unknown at Baghdád and Busreh. Large, soft, usually eaten as rutab only, and said to be superior to the better known Amír Hajj of the same oasis.

Halái, named after the village of Hala (?), one of the poorest of the Busreh dates; ripens early in October, and bears heavily. A yellow, dry date, about the size of Haláwí. Not common.

Hamráwí, an inferior Busreh soft date ripening in the last week of September. Its name suggests its color, "reddish," in shape it is small and slender. Scarce, shy bearer. Cures well and can be kept six months.

Hanúshíyeh, "The Date of Hanúsh" (a man's name), a rare Baghdád dry date of good quality but poor appearance. Form oblong to oblong-elliptical, broadest a little below center, base flattened, apex rather sharply pointed. Size medium large, one and three-eighths to one and five-eighths inches long, seven-eighths broad. Surface dry, roughly undulating, a dull, yellowish brown in color, often tinged with magenta near base; bloom unnoticeable. Skin medium thick, tough, dry, freely blistered and folded, and not adhering closely except around base. Flesh clear white or nearly so, changing to translucent amber brown near tip; three-eighths inch thick, solid, meaty but not mealy; fibre very slight. Seed oblong, rather slender, rounded at base, broadly pointed at apex, seven-eighths to one inch long, three-eighths to one-quarter inch broad, smooth, gray-brown, ventral channel closed or nearly so, germ pore nearer apex. Flavor very sugary, slightly nutty, similar to that of Badráhí and about as good. Ripens midseason.

Hiláli, "Moonbeams."* a delicious yellow date of the Persian Gulf, fairly common at Busreh, and providing rutabs up to December. It has been successfully grown in California, but its late maturity is a drawback to its wide cultivation. Described in Bul. Cal. State Com. Hort., Jan. '14.

Huwayzí, named after the town of Huwayzeh, sometimes spelled Hevezi, and frequently confounded with 'Awaydí. A choice Busreh soft date which is usually eaten fresh; the Arabs say it is inferior when cured, but this statement is hardly justified. A fairly long, slender date, more or less similar to Haláwí both in shape and color which is light brown. Ripens about the last week of September; the palm bears well from an early age, but is not common. Flavor delicate and pleasant. The fruit will keep for five or six months in good condition; experimental shipments made to New York have been successful.

* Literally, "The Crescent Moon." The root is an ancient Semitic one, and it is interesting to note that it is found in the expression Hallelujah = Hallelu-Yah, i. e., Lord of the New Moon; a liturgical phrase indicating that the ancestors of Abraham were devoted to the worship of the moon.

Ism'aíl Qadrí, (name of a man), a scarce Baghdád dry date which is also eaten in the rutab stage, and is esteemed. Bears well, late in August. Size large, color yellow, sometimes with a reddish-brown tinge.

Ja'afarí, "Refined Gold" (also a man's name), a rare and bad dry date of the Baghdád district. Yellow in color; so astringent that it is eaten only by camels.

Jamál al Dín, "The Beauty of Religion," a Mandalí date, which some connoisseurs esteem the best of that oasis, very rare at Baghdád. It is the earliest of the choice Mandalí dates to mature (August), and is usually eaten fresh, but occasionally preserved in skins. Light brown in color, fairly large in size. There is said to be no commerce in this variety, but wealthy proprietors at Mandalí each have a few trees for their own use.

Jauzí, "Like an English Walnut," a name which well describes both shape and color. An excellent dry date of the Baghdád district, not eaten in its soft state; bears heavily, shortly after midseason. Not very common. It is sometimes called Findúqíeh, or vulgarly Bindúqíeh.

Form broadly oval to almost spherical, widest near center. Base rounded, apex blunt to rounded. Size medium large, one and one-fourth to one and three-eighths inches long, one and one-eighth to one and one-fourth inches wide. Surface very rough, hard, dry, yellowish brown in color tinged with magenta; bloom unnoticeable. Skin medium thick, tough, deeply and coarsely wrinkled but adhering to flesh except for an occasional blister around apical end. Flesh very solid but not mealy, one-fourth inch thick, translucent brownish amber close to skin, creamy white toward seed; white portion three-fourths of whole. Seed broadly oblong, plump, three-fourths inch long, three-eighths broad, both ends broadly pointed; smooth, russet, ventral channel closed. Flavor sweet, nutty, mild and rich. The fruit varies considerably, however, and very inferior dates of this variety are sometimes found in the bazar.

Kákáwání, also spelled Kikawani and Chichawani, a variety mentioned by Ghanimeh but unknown to me. The name is Persian; a lexicographer says it means "excellent; applied to dates which have no seed." This is confirmed by Al Hamdaní, who gives in his "Description of Arabia" (10th century) a list of Busreh dates and among them: "Al Sísa, and it is called by the Persians Kika and Chícha and by the Arabs Al Fakhir (the fine) and probably it has a defective seed * * which can be eaten." I suspect that this variety is merely a Shís [An unfertilized or unpollinated date.—Ed.].

Kand Káwí, "The Bull's Penis" (Persian), a variety of which I heard the name only.

Khalásch, "Quintessence," the date of Hasa in Arabia, considered by Persian Gulf Arabs to be the finest in the world. It is extremely rare at Baghdád; at Busreh it is being planted a little more extensively of late years, but is not yet common. The quality of the fruit at Busreh is rather inferior;

it undoubtedly prefers a sandy soil. At Baghdád the growers claim its quality shows no deterioration; the annual yield is from 100 to 150 pounds.

I secured about 400 palms of this variety from Oman and Hasa; it is fully described in Bul. Cal. State Com. Hort., Jan. '14.

Khanayzí, (name of a tribe), an Oman variety, occasionally found at Busreh. Described in Bul. Cal. State Com. Hort., Jan. '14.

Khasáb, "The Abundant Producer," a variety that seems to be native of Oman, but is now becoming fairly common at Busreh, where it is valued because of its late maturity—fresh dates can be had from it until almost the first of December. It is rarely cured.

In the bazar the date is usually seen attached to the cluster, and before softening is of a bright, rose-red color, ovate-elliptical in form, widest near the middle and tapering slightly toward both ends. As it softens the skin becomes translucent and assumes a deep, reddish amber color, becoming sticky from the exudation of syrup.

The following description is of cured dates of this variety obtained in the Busreh market: Form broadly oval to broadly ovate, widest at center or slightly nearer basal end, thence tapering to the narrow, flattened base and the broadly pointed apex, size medium, length one and one-fourth inches, breadth seven-eighths inch. Surface irregular, reddish brown to prune purple in color, overspread with a thin bluish bloom; skin moderately thick, tough, coarsely wrinkled, transversely and longitudinally, but generally adhering closely to the flesh; flesh firm, tender, one-fourth to one-eighth inch in thickness, translucent, deep amber colored; seed oblong, round or blunt at base, pointed at apex, three-fourths inch long, five-sixteenths broad, smooth, deep grayish brown in color, ventral channel open, shallow, germ pore nearer base than apex; flavor sweet but lacking in character and with a rather strong after-taste.

Khasáwí al Baghal, "The Ass's Testicles,"* a variety said to be common and esteemed in Madína. It was introduced to Mesopotamia several generations ago but has never become widespread. The date is of large size, brown in color; eaten either fresh or cured.

Khiyara, "Cucumber-like" (Persian), a soft date originating with Mullah Nají of Baghdád, who claims it is the best in Babylonia. Long, slender, brownish-yellow, with a small seed. A heavy bearer and the bunches are very large; ripens in August. The flavor when fresh suggests that of a cucumber; packs and keeps well. Very rare.

Kibkab, often spelled (and pronounced) Chibchab or Chipchap. The word is Persian but its derivation uncertain; the best native lexicographer merely says it means "a palm which lets its fruits fall before they are ripe." I incline to the meaning, "The Date of the *Chab* tribe (properly Kab, a powerful and widespread tribe of nomads) on the left *chib*; (this is, the left bank of the Tigris ." It is a fairly common date throughout the Persian gulf; some-

* Al Muqaddisi (died 985) who lists 45 varieties of Busreh dates in his book "Ahsan al Taqásim" mentions Bayth al Baghal, "Ass's Eggs," which is very likely the same variety.

times eaten in a half ripe stage but usually boiled to form what is called *Kharak Pokhta* in Persian and *Khalál Matbúkh* in Arabic, in which state it forms a considerable article of export to India. The date ripens about October first, and the yield is large.

Form oblong-elliptical, widest near center, thence narrowing slightly to the flattened base and broadly pointed apex; size large, one and one-half to one and seven-eighths inches long, seven-eighths to one inch broad; surface hard, rough, golden brown in color; skin thick, hard and brittle, with many deep longitudinal wrinkles and a few transverse ones, but adhering very closely to the flesh, which is hard and dry, coarsely granular, five-eighths inch thick, brownish-white, opaque; seed oblong, blunt at base and rounded at apex, one inch long, five-sixteenths wide, fairly smooth, cinnamon brown in color, ventral channel almost closed, germ pore slightly nearer apex than base; flavor sweet but somewhat astringent. This description was made from boiled specimens.

Lúlúi. "Pearly," sometimes spelled Lilwee, following the vulgar pronunciation. One of the latest varieties, if not the latest, to ripen at Busreh (November), usually eaten when soft. Sometimes cured but will keep only a month or two. A heavy bearer.

When fresh the variety is dull yellow in color, the flesh soft, fairly sugary and of good flavor. When cured, the fruit is broadly oval to broadly ovate, sometimes almost spherical, widest at or near center, rounded toward the rounded base and rounded or broadly pointed apex. Size small, length seven-eighths to one inch, breadth at widest point seven-eighths inch. Surface almost smooth, brownish purple to purplish brown in color, bloom very slight; skin moderately thick, tough, usually not wrinkled but separating from the flesh in occasional slight folds or blisters. Flesh soft, syrupy, three-eighths inch thick, translucent, deep, brownish amber colored. Seed oblong, rounded at both ends or broadly pointed at apex; three-fourths inch long, three-eighths broad, smooth, grayish brown, ventral channel open near base only, germ pore nearer apex than base. Flavor sweet and moderately rich; pleasant.

Madaní, "From Madína," although it is said to have been brought to Baghdád from Mecca by returning pilgrims. Sometimes qualified as Madaní ahmar (red). A long and very large date of a reddish brown color, said to be a heavy bearer; ripens midseason. Can be eaten at any stage, but is preferred when only about half ripe. Sometimes cured and packed in baskets. Said to be the largest date at Baghdád; very rare. The palm is characterized by a particularly thick trunk.

Makkáwí. "From Mecca." Two varieties of soft date are designated by this name around Baghdád. The commoner is Makkáwí ahmar (red), scarce at Baghdád but said to be more plentiful in some of the outlying oases. Medium size, good quality and large yield; ripens early in September. Eaten

fresh or packed in skins. Makkáwí ashqar (sorrel) is probably only a subvariety of the same, ripens a little earlier, and does not keep.

Malqúṭí, a variety reported from Hilleh, of which I could get no particulars. The name means "that which is picked up off the ground after it has fallen."

M'awa, "Like an Intestine," a long, yellow, Baghdád variety, possibly a dry date, but is usually eaten when soft. Ripens early in September and is a favorite with the people because of the honey-like character of its flesh. Has been famous for centuries; its name is a classic.

Mulaffaf, "The Twisted," a small yellow dry date of Baghdád, remarkable for the spiral wrinkles of the skin, which make it look as if it had been twisted. Very rare. Eaten either fresh or dry.

Nabáṭí, named after a man or a town, a good but not common Busreh variety which seems to be on the border line between soft and dry dates. Ripens about October first. Good when fresh; must be dried in sun with care, if it is cured at all, and even then does not keep well. Shy bearer and requires more time to come into bearing than do most offshoots.

Form broadly oblong, obliquely flattened at base and broadly pointed at apex; size large, length one and one-half to one and three-quarters inches, breadth seven-eighths to one inch. Surface somewhat rough, glossy, translucent deep golden brown in color, bloom almost none. Skin medium thick but not tough, only slightly wrinkled but abundantly folded longitudinally and separating from flesh, which is firm, sometimes almost granular, thick, reddish amber close to skin, changing to light amber close to seed, not very translucent. Seed slender oblong-elliptical, pointed at both ends, one inch long, one-fourth wide, smooth, gray brown, ventral channel narrow. Flavor sweet, much resembling some of the good dry dates.

Nirsí, from the village of Nirs (?*), a good soft date grown in various districts on the river but apparently not at either Baghdád or Busreh. Ripens in the latter part of September; keeps well.

Form oblong, slightly wider toward basal end, rounded or slightly flattened at base, rounded to broadly pointed at apex. Size medium, length one and one-fourth to one and one-half inches, breadth five-eighths to three-quarters inch. Surface irregular, glossy, translucent light brown varying to orange brown; bloom unnoticeable. Skin thin, firm, tender, loosely wrinkled but adhering rather closely. Flesh firm, of caramel consistency, full of syrup, translucent, deep reddish amber in color, one-fourth inch thick, slight amount of fibre in seed cavity. Seed oblong-elliptical tapering very slightly toward both ends, length thirteen-sixteenths inch, breadth one-quarter, slightly roughened, grayish brown, ventral channel very shallow. Flavor rich, somewhat like that of Khadhráwí.

* Al Hamdani mentions a variety "Nirsián," from the same root.

Qaranfali, "Like a Pink (the flower)," possibly in odor. A large, yellow, dry date of good quality at Baghdád, which ripens early in September, and can be eaten either fresh or dry. Bears well. Scarce.

Qurrat Asharasí, "The Coolness (i. e., delightful freshness) of Asharasí," a Baghdád variety which is distinguished from Asharasí only by its slightly inferior size; they are sold indiscriminately together. Scarce. According to native idea, this variety is particularly sensitive to the odor of melons, and if one eats such a fruit under the palm, while the dates are unripe, they will all drop.

Rihávi, "The Fragrant," a Baghdád dry date, also eaten in its soft state. Sorrel colored, of medium size and good quality; ripens early in September; bears well; not common.

Sa'ada Aswád, "Black Happiness," a common Baghdád dry date of poor quality, but as it bears heavily it is considerably sold as food for asses. Form oblong-elliptical, flattened at base, widest near center, broadly pointed at apex. Size medium, length one and three-eighths to one and five-eighths inches, breadth three-fourths inch. Surface almost smooth, dry, slightly glossy, maroon purple in color, bloom unnoticeable. Skin moderately thick, tough, usually not wrinkled, but with a few folds and undulations; adheres closely to the flesh, which is firm, solid, one-eighth to three-sixteenths inch thick, light brownish amber in color, translucent. Seed oblong, rounded at base, rounded or broadly pointed at apex, seven-eighths inch long and five-sixteenths broad, quite smooth, russet in color, ventral channel almost closed. Flavor rather strong. This description was made from good specimens; much of the fruit in the bazar is smaller, drier and in every way inferior.

A sub-variety called Sa'ada Hamra (red) is distinguished, but it differs only in being lighter in color, and is not common.

Sáyir, "The Fibrous" (?), one of the most widely grown dates in Babylonia, although of inferior quality. It is also called Usta'amrán, and by that name is usually known at Baghdád; some experts profess to see a slight difference between the two, but their efforts are hardly successful. At Muhammarah this name is usually corrupted to Sa'amran; Sta'amran and Sambran are other vulgar pronunciations sometimes heard. The date is exported to America to a limited extent; plays an important part in native trade in the Persian gulf, and is the principal date grown on the Euphrates and the middle Tigris. It bears heavily, shortly before the first of October at Busreh, and will keep for a year or more. Said to do best in a sandy soil.

Form broadly oblong to oblong-elliptical, widest at center or slightly nearer apical end, whence it narrows almost imperceptibly toward the flattened base and broadly pointed apex. Size medium to medium large, length one and one-fourth to one and five-eighths inches, width three-fourths to seven-eighths inch; surface almost smooth, translucent, glossy, dark, orange brown in color, bloom almost unnoticeable; skin rather thick and tough, smooth except for occasional wrinkles or longitudinal folds in which it separates from the

flesh, which is rather soft, syrupy, one-fourth to three-eighths inch in thickness, deep amber colored, with considerable tender fibre around seed; the latter broadly oblong, rounded to blunt at both ends, three-quarters inch long, five-sixteenths broad, fairly smooth, grayish brown in color, ventral channel nearly closed, germ pore nearer base than apex; flavor very sweet, not cloying, but not rich or distinctive in any way. The dark color of the date is its principal drawback. Has done well in United States.

Saba'a al Dra'a, see Bú Saba'a al Dra'a.

Sayyid Ibráhim, (a man's name), is one of the largest of the Baghdád soft dates, but rare. Long in proportion to its width; light brown in color; ripens midseason; eaten fresh or cured; bears heavily.

Shaqra, see Ashqar.

Shakkar, "Sugar," often called Shakkarí,* an inferior Busreh soft date, not to be confounded with those of similar name at Baghdád. Of medium length and slender, light brown in color, ripening late in September; a shy bearer; not common. Eaten principally fresh, but will keep a month if dried.

Sharisí, "Of a bad disposition," a fairly common Baghdád variety but on account of its poor quality is usually eaten only by animals, for which reason the cultivator usually does not pollinate it. A long and slender but small date, light brown in color; can be eaten fresh or packed in skins or boxes. It is often called Shís, "unfertilized."

Shatwí, "Wintry," the latest of the Baghdád dates to ripen (November) but of fairly good quality. Usually eaten fresh, but keeps well. Not common.

Form oblong, widest at center or toward basal end, flattened at base and blunt to broadly pointed at apex. Size medium, length one and one-quarter to one and one-half inches, breadth three-fourths to seven-eighths inch. Surface dry, roughly undulating, opaque dull magenta in color near base changing to translucent deep amber brown near apex; bloom very slight, blue gray. Skin dry, firm, rather thick and tough, coarsely wrinkled and blistered, adhering closely around base but often separating toward apex. Flesh solid, meaty, three-eighths inch thick, translucent amber brown in color, rather fibrous around seed, which is oblong, slightly swollen in center, base and apex rounded, length seven-eighths inch, breadth three-eighths; smooth; light

* This, again, is a Persian word; the Arab form "sukkar" is, also, in use at Baghdad, both for the article *sugar,* and as the name of a date variety. Our word "sugar" is, of course, of the same origin, all three forms deriving from the Sanskrit *cakara,* which meant either sugar or—sand! One of the commonest Arab methods of forming a date variety-name is to make an allusion to sugar in some way; such is the excellent Baghdad variety Tabirzál, which was originally Tabirzád or Tabarzadh, a Persian word again. Cf. a classical Arab lexicographer's definition of "sukkar": "A certain sweet substance, well known; it is hot and moist, according to the most correct opinion; but some say cold; and the best sort of it is the transparent, called Tabarzadh; and the old is more delicate than the new; it is injurious to the stomach, engendering yellow bile; but the juice of the lemon and orange counteract its noxiousness; it is said to be a word recently introduced, but some say that it occurs in one Tradition" (of Muhammad. The use of a word by the Prophet is the highest recommendation it can have for etymological respectability).

brown; ventral channel open but shallow, germ pore slightly nearer apex. Flavor rather strong, but nutty, somewhat similar to that of a good dry date.

Sin Mufta, a variety mentioned by Colvill,* which I could not identify.

Shuwaythi, "The Little Bees' Date" (?), a Busreh soft date resembling Khadhráwí but a little smaller. Ripens in October; not good when fresh but fairly good when cured; keeps eight or nine months. Scarce and a shy bearer.

Tabashir, "Calcareous," probably from its chalky color, a variety of which I could get no more than the name. Doubtless a dry date.

Ukht Badra, "Badra's Sister," a name which indicates the similarity of this dry date of Baghdád to the distinct and commoner Badráhí. A rare variety, but sometimes found in the bazar.

Form oblong, slightly wider toward apical end, flattened at base and rounded to broadly pointed at apex. Size medium large to large, one and one-fourth to one and five-eighths inches long, seven-eighths to one inch wide. Surface dry, hard, smooth or somewhat undulating, dull yellowish brown in color, sometimes brownish yellow. Skin thin, dry, rather tender, occasionally slightly wrinkled or creased. Flesh three-eighths inch thick, light yellow near skin, changing to silvery white near seed; solid and meaty, but neither mealy nor brittle; dry, slightly fibrous around seed. Seed broadly oblong, rounded at base and apex, seven-eighths inch long, three-eighths wide, smooth, gray brown, ventral channel deep, germ pore slightly nearer apex. Flavor sweet and nutty.

Usta'amrán, "The Date of 'Amr the Expert" ('Amr is a common man's name). A synonym for Sáyir, q. v.

Umm Ajrabeh, "Mother of Quantity" (the ajrabeh is a grain measure containing 768 pounds) or "Mother of the Mange". If taken in this last sense, the name probably means that the palms of this variety are particularly affected by the Parlatoria scale, which is colloquially known as "date-palm mange". A rare Baghdád soft date, much similar to Khustáwí in appearance, but a little smaller. Ripens in midseason. Noted as a heavy bearer, as the first signification of its name would indicate.

Umm al Sawáni, "Queen of the Table" or, more literally, "Mother of Platters". The name is colloquially pronounced Umuswani. A small, short, fat date known at Baghdád, but confined to a few gardens. It is eaten only in the fresh or rutab stage, when its color is a brownish yellow.

'Uyun Ayub. The latter word is the name, in Arabic form,† of the Biblical Job, the former has some fifty meanings in addition to its primary one of "eyes," As Job's Eyes seems senseless, I suggest (without any definite warrant from Arab sources) the translation "coins" which is etymologically

* In Jour. Linn. Soc. London, vol. XIV, p. 505.

† The translators of the King James version of the Bible blindly copied Martin Luther in transliterating proper names, without stopping to think that the difference between German and English was wholly misleading in such cases as this. Job and Jacob would pass in German, where they correctly give the oriental pronunciation; but in English, with a different value for *j,* the translators should certainly have written Yob, Yacob, etc.

entirely justifiable. The name could then be linked to the Arabic tradition given by Shaykh Jalal al Dín (15th c., A. D.) in his Commentary on the Koran, and elsewhere, that Job had two threshing floors, one for wheat and one for barley, and that after his prosperity had been restored, God sent a cloud over each of these threshing floors, raining gold pieces on one and silver pieces on the other, until they were wholly covered. The fruit which bears this name is a rather small, yellow, dry date of Baghdád, scarce but esteemed. It ripens in midseason and the yield is said to be average.

Zahríych, "Flowery" or "Brilliant," a variety mentioned by Ghanimeh, but unknown to me personally.

In addition to these, Dr. Zwemer* mentions the following as being dates of the Busreh region: "Mother of Perfume," "Sealed Up," "Red Sugar," "Pure Daughter," and "Daughter of Seven." I can not be certain of these identifications; but "Mother of Perfume" may be Ríháwí; "Sealed Up" is probably Maktúm; and "Daughter of Seven" is probably the same as "Father of Seven to the Cubit."

I may add that of the 111 varieties of dates described in Baghdád by native writers of the eighth, ninth and tenth centuries, and collected by Père Anastase Marie of the Carmelite Mission, Baghdád,† not more than fifteen or twenty can be identified definitely as existing up to the present day. Some of them are probably now going under other names; but no doubt most of them have become extinct, as better varieties took their places.

MALE VARIETIES.

The principal variety of male date palm in the Busreh region is Ghanamí, "Bushy Head," which gives pollen in its third year, blooms early in the season, and produces from twenty to thirty spadices annually.

Other male varieties of this region are Hukrí, whose name signifies, probably, "what is laid by in times of scarcity" and points to the storing of pollen from year to year (although such a practice is extremely rare in Babylonia), Wardí, "Long Haired", and Sumaysmí, which is probably a colloquial pronunciation of Shumaysmí, "little Sunburst," in allusion to the thick crown of foliage.

At Baghdád a dozen or more varieties of males are distinguished, merely by the name of the female variety of which they are originally supposed to have been seedlings (although now propagated by offshoots, of course). The best of these is Asharasí, which sometimes bears forty or fifty spadices, the Arabs claim; and they declare that not only is the yield of fruit heavier when this variety of male is used for pollination, but that the flavor of the dates is also better. It is, accordingly, the only variety planted by connoisseurs, but lacking this, Bárbán is preferred, with Khadhráwí in third place.

In importing specimens of the male Asharasí to California, I endeavored

* Zwemer, S. M., in "Arabia, the Cradle of Islam." New York, 1901.

† See Loghat el Arab, XI, 509, Baghdad, Mai, 1913.

to avoid confusion with the female by dropping the last syllables and adding the Arabic word for male; so it now appears as Ashar Fahal.

It is worth noting that the classical writers do not, apparently, know any named varieties of male, but mention merely "Fahal" or, in the plural, "Fahâhîl."

In order to complete private files and in order to obtain special articles which appeared in the first number of this JOURNAL, namely, that for February, 1911, numerous requests have been received for copies of that issue. Since the supply of that number at Pomona College has been exhausted, the editor will be pleased to purchase a number of copies from persons willing to sell them at twenty-five cents each.

A Backward Look and a Forward Look

By DAVID L. CRAWFORD
Professor of Botany in Pomona College

With this issue the third and final volume of the Pomona Journal of Economic Botany is closed. In a new form, however, and under a new name it will be continued. Begun in 1911 by Professor Charles Fuller Baker, the Journal has contributed richly to the advancement of subtropical horticulture in California. Each number has been filled with valuable and interesting information and illustrations. Professor Baker's connection with the Journal ended in 1912 when he accepted a position in the University of the Philippines as Professor of Agronomy in the College of Agriculture. Unfortunately for the Journal, it was impossible for his successor to issue the quarterly numbers when they were due, because of certain difficulties. During the two years in which the second editor issued the Journal only four numbers appeared, dated and numbered according to their due time of issue. The third editor, the present writer, now takes up this work.

It is gratifying, in retrospect, to see the signal success to which this Journal attained from its beginning. This success was due chiefly to two factors, namely, the unique ability of the first editor, and the great need in this country for such a publication. There are few men living who have a greater capacity for work and who are more tireless in their work than Charles F. Baker. He is a man who sees big visions and who, instead of dreaming, sets about with joyful zeal and a bulldog determination to make these visions realities. As a friend, one can want no better. As an enemy, one never is in doubt as to his opinions and sentiments. He is open-hearted and large-hearted. One feels a strong stimulus to a better and a larger life when he comes into contact with this man.

Mr. Baker saw the need for a publication of this kind in California, which would disseminate practical knowledge concerning the subtropical trees and plants and fruit crops which are or might be useful on the Pacific Coast. The Pomona Journal of Economic Botany was the only journal of its kind in the entire country and met with much demand, for this is essentially a subtropical region and not far away in several directions are tropical countries. The horticulture of this country is sure to become more and more like that of the tropics, and to hasten this development was the object of the new publication.

This need is increasing in all southern countries, especially in the southern portions of the United States. Tropical agriculture and horticulture are becoming very important in the economy of the world today. More people are going south to engage in the more profitable tropical agriculture and more money is

being thrown into its development. More schools and colleges are springing up to teach the science and practice of this branch of agriculture. All over the world it is becoming of vast importance.

A publication such as was begun by Professor Baker cannot now be limited to a small region. It must be broad in its scope and must be useful in developing and advancing all branches of tropical and subtropical agriculture and horticulture in all parts of the world where they are practiced. Toward this end, a change is to be made in the Journal. It will be issued under a name name, with new policies and a broader scope, and by a large group of the world's foremost experts in tropical agriculture. A further notice of this will be issued at a later date, when the plans are more nearly complete.

Price List of Reprinted Articles*

IN THE

POMONA JOURNAL OF ECONOMIC BOTANY

THE BOTANIC GARDENS OF PARA (BRAZIL), by *C. F. Baker*, 1911
9 pages, 7 illustrations.....10 cents

NOTES ON SCLEROPLEA AND MYCOSPHAERELLA ON CITRUS TREES, by *C. W. Metz*, 1911. 2 pages, 1 illustration.....5 cents

MODERN AGRICULTURE IN MEXICO, by *D. L. Crawford*, 1911
11 pages.....5 cents

BOTANY OF THE BRAZIL NUT, by *W. J. Young*, 1911
6 pages, 4 illustrations.....10 cents

THE MANGO IN SOUTHERN CALIFORNIA, by *F. W. Popenoe*, 1911
48 pages, 13 illustrations.....25 cents

FEIJOA SELLOWIANA—ITS HISTORY, CULTURE, AND VARIETIES, by *F. W. Popenoe*, 1912. 26 pages, 13 illustrations.....20 cents

THE PALMS INDIGENOUS TO CUBA (in three parts bound together) by *O. Beccari*, 1912-1913. 77 pages, 39 illustrations.....40 cents

THE CHERIMOYA IN CALIFORNIA, by *F. W. Popenoe*, 1912
24 pages, 16 illustrations.....20 cents

WANTED: A GENUINE SOUTHERN CALIFORNIA PARK, by *R. D. Cornell*, 1912
14 pages, 9 illustrations.....15 cents

STEM-ROT DISEASE OF CARNATIONS CAUSED BY A SPECIES OF FUSARIUM, by *Clayton J. Wright*, 1912. 16 pages, 5 illustrations.....10 cents

THE BOTANIC GARDEN OF OAXACO, MEXICO, by *Prof. C. Conzatti*, 1912
5 pages, 1 illustration.....5 cents

CITRUS FRUITS, DATES AND OTHER CROPS IN THE COACHELLA AND IMPERIAL AND YUMA DISTRICTS, by *R. D. Cornell*, 1912. 9 pages.....5 cents

ROSELLE (HIBISCUS SABDARIFFA L.), by *Eugene S. Heath*, 1912
4 pages, 2 illustrations.....5 cents

THE PROPAGATION OF THE DATE, by *R. D. Cornell*, 1913
6 pages, 3 illustrations.....10 cents

IMPORTED VARIETIES OF THE AVOCADO FOR SOUTHERN CALIFORNIA, by *K. A. Ryerson*, 1913. 16 pages, 11 illustrations.....15 cents

TEA GROWING IN TRANSCAUCASIA, by *Chas. E. Bessey*, 1913
5 pages, 4 illustrations.....5 cents

CALIFORNIA STREET TREES, by *R. D. Cornell*, 1913
13 pages, 9 illustrations.....10 cents

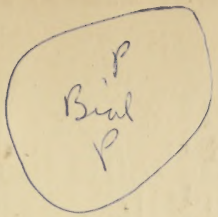
BABYLONIAN DATES FOR CALIFORNIA, by *Paul B. Popenoe*, 1913
19 pages.....10 cents

*The supply of many of the reprints has been exhausted, but some of them may be obtained by addressing a request direct to the author. The following may be obtained by addressing POMONA COLLEGE, DEPARTMENT OF BOTANY.

Index to Volumes I, II and III (1911-1913)

Acacia *Baileyana* . . . . . page 97
dealbata 95
longifolia 94
melanoxylon 94
Acacias for the Southwest 91
Acacia trees for the street 457
Acoelorraphe wrightii 391
Acrocomia aculeata 367
crispa 364
Agriculture, Modern in Mexico . 111
Anona *glabra* 296
macrocarpa 295
montana 296
muricata 296
palustris 298
reniformis 295
reticulata 298
squamosa 299
suavissima 295
Anonaceous fruits 277, 295
Anthracnose of citrus trees . . . 25
Asimina triloba 300
Avenue trees 128, 201
Avocado, budding of 7
industry 135
in Florida 136
in Southern California 3
propagation of 7
trees for the street 456
varieties imported 457
varieties, list of
Atlixco 433
Baldwin 24
Blackman 24
Blake 4, 21
California Trapp 430
Cardinal 20
Chappelow 18
Chili 428
Cyrus 24
Family 19
Fowler 16
Furnival 438
Ganter 6, 17
Harmon 8, 20
Ideal 426
Itzia 439
Johnstone 24, 439
Landon 21
Largo 24
Lyon 22
Millar 21
Modesto 438
Montezuma 435
Pollock 20
Popocatapetl 439
Puebla 429
Quality 21
Queretaro 428
Redondo 430
Rico 24
Sinaloa 16, 435
Sterling 24
Trapp 15, 430
Two Pound Green 426
Walker 4, 22
Wester 19
White 6, 21
Bactris plumeriana 371
Baker, C. F. . . . 1, 64, 104, 128, 214
Bamboo 453
Bambusa aurea 453
Baccari, Edoardo 253, 351, 391
Bertholetia (Brazil nut) 122
Bessey, Chas. E. 441
Botanic Gardens in Brazil (Para) 64
in Mexico (Oaxaca) 337
Southern California 104
Bottle Palm 398
Brazil Nuts 122
Budding avocado trees 7
citrus trees 149
mango trees 162
Calyptrogyne swartzii 356
Camphor trees for streets 457
Carnatian, Stem-rot disease of . . 315
Carob Tree (*Asatonia*) 457
Castanea (Chestnut) 455
Cedar, Himalayan 453
Cedrus deodara 453
Cherimoya in California 277
Cherry, Island 458
Chestnut tree *(Castanea)* 455
Citrus anthracnose 25
canker 25
die-back 73
exanthema 73
fruits in Imperial Valley . . . 342
fungi 109
leaf-spot 25
lemon-spot 25
stock improvement 149
tearstain 25
wither-tip 25
Coachella Valley, Fruit culture in 342
Coccothrinax acuminata 410
crinita 410
martii 410

miraguana 408
rigida 409
Cocos palm for street 451
Colletotrichum glocosporioides . . 25
Conzatti, Prof. C. 337
Copernicia curtisii 395
glabrescens 395
hospita 394
macroglossa 395
Cornell, R. D. 98, 209, 243, 301, 342, 382, 418, 446
Crawford, D. L. 57, 111
Date growing in Imperial Valley 345
Dates, Babylonian in California . 459
male varieties 476
propagation of 418
varieties of 462
Die-back of citrus trees 73
control of 80
Essig, E. O. 25, 73
Erythrea armata 452
Eucalyptus diseases 249
Eucalyptus globulus 455
viminalis 447
Euterpe globosa 351, 353
Exanthema of citrus trees 73
Expedition, Biological to Mexico 57
Fan Palm, Sonorae 450
Blue 452
Feijoa sellowiana 217
Ficus macrophylla 456
Figs in Imperial Valley 347
Foreword by Editor 1
Franceschi, C. F. 201
Fusarium species on carnations . 315
Gaussia attenuata 275
princeps 272
Grapes in Imperial Valley 348
Heath, Eugene S. 378
Hemithrinax compacta 402
Hendersonia disease of Eucalyptus 249
Hibiscus sabdariffa (roselle) . . 378
Imperial Valley, Fruit culture in 342, 418
Java, horticulture in 214
Landscape gardening 98, 209, 243, 301, 382
Lemon spot 25
Limoneira Ranch 149
Lyonothamnus floribundus 456
Mango in California 153
Mayten tree 458
Metz, C. W. 109
Mexico, biological expedition to . 57
botanic gardens 337
modern agriculture in 111
Mycosphaerella lageniformis . . . 109
Oiea curapea 454
Olive trees for streets 454
Oreodoxa charibaea 263
oleracea 265
princeps 266
regia 257
Palms of Cuba 253, 351, 391
root growth in 412
stem thickening 411
structure 411
Para (Brazil), Botanic gardens in 64
Park, A genuine in Southern California 310
small city 382
Pepper tree 448
Persea gratissima 456
Pittosporum undulatum 457
Plans for yard gardens . . 98, 209, 243
Plants for yard gardens . 98, 209, 243
Platanus racemosa 455
Popenoe, F. W. 3, 83, 135, 153, 217, 277, 459
Pritchardia wrightii 391
Prunus integrifolia 458
Pseudophoenix sargentii 269
Rolfs, P. H. 107
Rollinsia emarginata 300
orthopetala 300
Roselle *(Hibiscus sabdariffa)* . . 378
Ryerson, K. A. 424
Sabal florida 376
parviflora 375
yapa 376
Sapote, white 83
Schinus molle 448
Sclerophlea aurantiorum 109
Slopes and terraces 243
Spoor, E. H. 91
Stem-rot of carnations 315
Street trees 128, 201, 446
Sycamore 455
Tea growing in Transcaucasia . . 441
making process 444
Terraces, gardens on 243
Thrinax drudei 404
punctulata 405
wendlaniana 403
Truck crops in Imperial Valley . 349
Vaile, R. S. 149
Washingtonia sonorae 450
West India Gardens 428
Wight, C. J. 315
Wither-tip 25, 107, 109
Young, W. J. 122
Yuma, (Arizona), fruit culture in 342


P
Biol
P